The SCIENTIFIC MONTHLY

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CONTENTS

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

In 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientific work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 25,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

ALEXANDER E. SKUTCH, Ph.D., botanist and ornithologist. See p. 260 in this issue.

HARVEY A. ZINSZER, Ph.D., has been Professor of Physics and Astronomy at Fort Hays Kansas State College, Hays, since 1929. He arrived at his present position by a long and arduous route. The son of a village blacksmith, he was born near Allentown, Pennsylvania, in 1886. Starting work as a Western Union messenger boy at 16, he rose to assistant manager of the Allentown office before he entered Allentown Preparatory School in 1907. Graduating in 1909, he continued his career in commercial communications until 1918 when he became instructor of radio to enlisted men at Lehigh University. He remained on the campus as student and teacher until 1924, receiving his B.A. and M.A. He took his doctorate in physics at Indiana University in 1926. He was then the father of four children. Dr. Zinszer is now president of the Kansas Academy of Science and is active in many other professional organizations.

RUFUS SUTER, Ph.D., is a genuine Doctor of Philosophy, having received his doctorate in philosophy at Harvard in 1932. Now 39, his army service was terminated by age, and he is engaged in confidential war work in Washington, D. C. He lives at 1904 Southern Ave., S.E. Dr. Suter is a native of western Pennsylvania and a Harvard man throughout his higher education. From Harvard he went to the Library of Congress as a cataloguer in philosophy. For two years he held a fellowship at the Asiatic Division of The Library of Congress and contributed biographies for *Eminent Chinese of the Ch'ing Period*, edited by Arthur W. Hummel (1943). His avocation concerns the history and nature of the scientific method, exemplified by his present article and previous articles in *The Scientific Monthly* on Aristotle, Galileo, Hume, and Watt.

NEW BOOKS

Knowing the Weather. T. MORRIS LONGSTRETH. 19 Ills. xiii + 150 pp. 1943. $1.69. Macmillan.

The behavior of the atmosphere, its drama and beauty, is discussed in a lively personal style. Cyclones, clouds, winds, temperature, rains, snow, storms, fog, ice, and measuring instruments are among the topics treated in this book on the fundamentals of weather and the practical aspects of being air-wise.

Henry S. Pritchett. ABRAHAM FLEXNER. 3 Ills. iv + 211 pp. Dec., 1943. $2.75. Columbia University.

Dr. Flexner, who worked under Pritchett in 1908–12, surveys the life and work of one of America's foremost educators, showing the broad understanding and wide sphere of influence of a man whose life included heading the Coast and Geodetic Survey, M.I.T., and the Carnegie Foundation for the Advancement of Teaching.

American Women of Science. EDNA YOST. xviii + 232 pp. 1943. $2.00. Stokes.

Brief biographies of twelve great women, all but two of whom are still alive, have been compiled by the author to demonstrate the importance of women in the advancement of civilization. Among these are Alice Hamilton, outstanding authority on industrial medicine, and Florence Rena Sabin, famous for researches on blood vessels and tuberculosis.

Introduction to Exceptional Children. HARRY J. BAKER. Ill. xiv + 496 pp. 1944. $3.50. Macmillan.

This is a college textbook written by the Director of the Psychological Clinic of the Detroit Public Schools. Dr. Baker presents the facts and offers valuable suggestions relating to different types of exceptional children, including the physically handicapped, the mentally subnormal, and the gifted.

Northern Fishes. SAMUEL EDDY and THADDEUS SURBER. 93 Ills. xi + 252 pp. Nov., 1943. $4.00. University of Minnesota.

The species and subspecies of over 150 freshwater fishes inhabiting the waters of the Upper Mississippi Valley are fully described and illustrated in this manual for sportsman, ichthyologist, or conservationist. Special sections are devoted to lake and stream improvement and conservation, fish production and management, structure, classification, and origin of fishes.

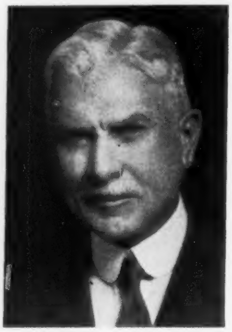
Medicine and the War. Edited by WILLIAM H. TALIAFERRO. Ill. vi + 193 pp. 1944. $2.00. University of Chicago.

This volume contains ten Charles R. Walgreen Foundation lectures by members of the faculty of the Division of Biological Sciences, University of Chicago. It provides laymen with current information on the following vital topics related to the war: food, chemotherapy, malaria, modern transportation and disease, aviation medicine, brain injuries, psychiatric disorders, shock and blood substitutes, chemical warfare.

Peoples of Southeast Asia. BRUNO LASKER. Ill. 288 + x pp. 1944. $3.00. Knopf.

The broad subject of this book, prepared under the auspices of the American Council of the Institute of Pacific Relations, is the 150 million brown and yellow peoples of Burma, Thailand, Malaya, Indo-China, the Philippines, and Netherlands Indies—their changing ways of life and their and our mutual needs in the present struggle for freedom.

MEET THE AUTHORS, Continued



E. W. GUDGER, Ph.D., Honorary Associate in Ichthyology, American Museum of Natural History, New York City, is a pillar of *The Scientific Monthly*. Our incomplete records show that his present article is the thirty-third that he has published in the *Monthly* since 1927; his total bibliography comprises 268 titles. Dr. Gudger was born in 1866 at Waynesville, N. C., near the Great Smokies. He attended Emory and Henry College, Virginia, and the University of Tennessee. He received his doctorate from Johns Hopkins in 1905. For the next fourteen years he was Professor of Biology at the Woman's College of the University of North Carolina and during this period served as an investigator at the Beaufort, N. C., Laboratory of the U. S. Bureau of Fisheries and at the Tortugas, Fla., Laboratory of the Carnegie Institution of Washington. Since 1919 he has been associated with the American Museum of Natural History, first as editor of the Bashford Dean Bibliography of Fishes and then as Assistant and Associate Curator of Fishes. He deserves the thanks of every reader of *The Scientific Monthly* for his entertaining but factual fish stories.

PHILIP L. ALGER, M.A., M.S., is chairman of the General Standardizing Committee of the General Electric Company, Schenectady, New York. He was born in Washington, D. C., in 1894 and was educated at St. John's College and Massachusetts Institute of Technology. In World War I he served as a Lieutenant in Ordnance. His engineering career with G.E. began after the war and has been concerned with design and development of motors and generators. Ten patents on electrical machinery have been issued to him. He is notable for rendering much public and professional service outside of his regular duties.

W. H. HODGE, Ph.D., is a field botanist in Peru. See *The Scientific Monthly*, March, 1944, p. iv.

MEET THE AUTHORS, Continued

Blackstone Studios

ALVAN L. BARACH, M.D., is Associate Professor of Clinical Medicine in the Columbia College of Physicians and Surgeons and is also Director of the Aviation Research Laboratory, Columbia University, New York City. He took his M.D. at Columbia, and interned and later practiced at the Presbyterian Hospital, New York City. Dr. Barach was born at Newcastle, Pa., in 1895 and has spent his entire professional career in research on and application of gas therapy. He has received professional awards in recognition of the several important developments in gas therapy for which he is responsible and which he describes in his present article. His current investigations in the physiology of anoxia (lack of oxygen) are of course of importance to our sky-high war. A technical book on his specialty will be published under the title *Principles and Practices of Inhalational Therapy.*

LOUIS WIRTH, Ph.D., Professor of Sociology, University of Chicago, is regarded as one of the leading students of the social organization of Chicago. In 1911 he came to the United States from Germany, where he was born in 1897. He received his secondary education in Omaha, Nebraska, and all his higher education at the University of Chicago. In 1928 he was appointed assistant professor at Tulane University. In 1930–31 he pursued sociological research in Europe under a Social Science Research Council fellowship. Then he returned to the University of Chicago as associate professor of sociology. He was appointed professor of sociology in 1940. Dr. Wirth has been an editor of the *American Journal of Sociology,* consultant to the National Resources Committee, and president of the Society for Social Research. An able speaker, he has been a frequent participant in discussion of the nationally broadcast University of Chicago Round Table. His sociological specialty is urbanism in the United States.

NEW BOOKS

Civilization and Disease. HENRY E. SIGERIST. 52 Ills. xii + 255 pp. 1943. $3.75. Cornell University.

The Messenger Lectures on the Evolution of Civilization delivered in 1940 at Cornell by Professor Sigerist of Johns Hopkins have been assembled in 12 illustrated chapters showing how disease, by affecting man's life and actions, has influenced his creations also. Disease is discussed specifically in relation to economics, social life, the law, history, religion, philosophy, science, literature, art, and music.

The Helicopters Are Coming. C. B. F. MACAULEY. Ill. xii + 165 pp. Feb., 1944. $2.00. Whittlesey House; McGraw-Hill.

The author of this popular book projects the helicopter future, relates the history of the mechanical "hummingbird," describes various designs and probable private and commercial uses, and in general predicts the major social changes that will be wrought by the post-war introduction of the helicopter as the vehicle of everyday.

Steel in Action. CHARLES M. PARKER. Ill. vii + 221 pp. Dec., 1943. $2.50. Jaques Cattell.

This is the story of iron and steel told extensively and for the layman. Beginning with a historical survey, it describes the manufacture of iron and steel products from ore to finished product, their distribution, related economics, latest technological advances, and the effect of steel in the post-war world.

David Dale Owen. WALTER BROOKFIELD HENDRICKSON. 7 Ills. xiii + 180 pp. 1943. Indiana Historical Bureau.

The life-work of David Dale Owen (1807–1860), "pioneer geologist of the Middle West," is reconstructed largely from Owen's manuscripts, official reports and published scientific papers. The book reveals his important contributions to the knowledge of economic and scientific geology in the United States. It describes, among other accomplishments, Owen's great surveys of Indiana, the Northwest, and Arkansas.

Meet Doctor Franklin. vi + 234 pp. 1943. $2.50. The Franklin Institute.

Contributions from 12 eminent contemporary scholars consider the versatile genius of a great American. These were originally read at a series of "Meet Dr. Franklin" gatherings designed so that "Benjamin Franklin's philosophies of life could be refocussed as a guide in these uncertain times." Franklin is portrayed as scientist, statesman, philosopher, printer, agriculturist, economist, and as an individual.

Power and Flight. ASSEN JORDANOFF. Ill. 314 pp. Feb., 1944. $3.50. Harper.

In this popular presentation the author discusses the modern aircraft powerplant—its various constituents, its functions, and different processes in servicing. The exposition is clarified by the inclusion of many photographs and expert drawings.

The Johns Hopkins Hospital and The Johns Hopkins University School of Medicine. Vol. I. ALAN M. CHESNEY. 37 Ills. xviii + 318 pp. 1943. $3.00. The Johns Hopkins Press.

In this first volume of the history of these interrelated institutions, Dr. Chesney, present Associate Professor of Medicine and Dean of the Medical Faculty, covers extensively the period from the incorporation of the University and the Hospital in 1867 to the opening of the School of Medicine in 1893.

MEET THE AUTHORS, Continued

Blackstone Studios

George Lawton, Ph.D., is a consulting psychologist, founder and director of the Old Age Counselling Center at 2 E. 54th St., New York 22, N. Y. He was born in 1900 at New Haven, Conn., but soon became a New Yorker, taking all his degrees at Columbia. He emerged a psychologist and about 1929 he was professionally engaged in the psychological treatment of problem adolescents. Tracing the troubles of children to maladjustments of their parents and grandparents, his interests shifted to older people and since 1937 he has devoted himself to their adjustment problems. Dr. Lawton advocates the widespread establishment of old age counselling centers and an institute for research in aging to deal with the challenge represented by our increasing numbers of older people. *New Goals for Old Age*, edited by him, crosses professional lines in a way that might serve as a guide for a research institute. Dr. Lawton is not depressed by old people; he is making a collection of funny stories dealing with their problems, possibilities, and pleasures.

Ralph F. Shaner, Ph.D., is Professor of Anatomy at the University of Alberta, Edmonton. A native of Pennsylvania (born in 1893), he is now a naturalized citizen of Canada. Dr. Shaner was turned from law to natural science by Professor Davison of Lafayette, who furnished the inspiration for his present article. His graduate work was done at Harvard under Dr. F. L. Lewis, comparative anatomist of the Harvard Medical School. Since 1921 he has been teaching anatomy in Alberta and writing on reptilian and mammalian embryology. Engaged in a field in which research is seldom spectacular and having borne the contumely of more pretentious scientists and educationalists, he sometimes suspects a little humbug in both. Dr. Shaner's hobbies are gardening, mushrooms, and bees, all appreciated by his family; and the clarinet, which is not.

THE SCIENTIFIC MONTHLY

APRIL, 1944

A PARABLE FOR PEACEMAKERS

By ALEXANDER F. SKUTCH

HERE in this tropical valley live untold thousands of birds of several hundred distinct kinds. They dwell together in a degree of peace and harmony that is surprising when one considers their number and diversity of habits. Since a large proportion remain paired throughout the year and occupy continuously the little plot of ground in which they nest, disputes for the possession of mates and nesting-ground are far less frequent and violent than among northern birds, which in general are migratory and each spring must find mates and claim their nesting territory anew. Here predatory members of the avian world are rare; and an almost Utopian good-fellowship prevails among the local birds.

But there is one outstanding exception, one perpetual disturber of the harmony that prevails among two hundred kinds of birds. It is a small flycatcher, with dull brownish upper-plumage and a dingy yellow breast streaked with narrow dusky lines—altogether a bird neither beautiful nor distinguished in aspect, and one that would attract the eye of none but the enthusiastic bird-watcher armed with his field glasses. Early in the sunny month of February, this plainly clad little flycatcher arrives in our valley, and at once proclaims his presence by a variety of thin-toned, breezy whistles that seem to be the spontaneous outpouring of a careless, easy-going, vagabond nature. In these airy, carefree utterances, one searches in vain for some trace of the earnestness of his neighbor and relative, the yellow-breasted chipsacheery flycatcher, the depth of feeling of the brown thrush, or the retiring modesty of the blue grosbeak. They seem to be the self-revealing expression of a nature at once light-hearted and shallow, bound by no ties. Only the persistency of his repetition of the long-drawn *pee-e-e-e*, and the high-pitched, rapid *pee-de-de-de*, might lead the perspicacious student of avian nature to suspect that there lurked behind that voice a vein of stubborn pertinacity unexpected in a character so gay and breezy. Yet, if poetry flourished here amid the vast forests of southern Costa Rica, the local bards might seize upon and celebrate the voice of the striped flycatcher as the true harbinger of spring, as European poets have taken the voice of the cuckoo, and North Americans the songs of the bluebird and the robin.

Yet, to a certain section of the local bird population, I fear that the airy whistles of the striped flycatcher are anything but a message of gladness and good cheer. At this season, I fancy that I hear the yellow-breasted gray-capped flycatchers exclaiming to their mates in their thick, earnest voices, and the chipsacheeries repeating in their soft, high tones: "Confound it! So that pest is back again!"

For in March, the month of gathering clouds and the first light evening showers, the gray-caps and the chipsacheeries, together with a host of other birds of the most diverse kinds and colors, begin to fashion their nests, that they may bring forth their young in the verdant, flowery period of April and May, when flourishes an abundance of insect life that lightens the task of filling hungry nestling mouths. But not so the striped flycatchers; instead of setting about to prepare their nests, they continue to perch idly in the treetops, now and again darting forth to snatch up passing insects, and continue their thin whistles, as breezy and care-

free as ever. Not for this pair the joyous occupation of choosing, male and female together, the site of the future nest, amid the dark foliage of orange or lemon tree, or at the leafy end of some long bough overhanging the sparkling current of the river, close beside a hive of stinging wasps that will fiercely punish any heavier, less aerial creature that shakes the swinging branch. Not for the female striped flycatcher the pleasant task of building the nest, while her mate perches close by, dropping a cheery note of encouragement each time she passes him with a straw in her bill. The striped flycatchers have other ends in view; they watch and whistle while other birds build their nests.

At length, after a week or two of unhurried labor, the gray-cap, or her cousin the chipsacheery, has completed her nest, a commodious structure of dry straws and weed stems, with a high domed roof to shield the occupants from sun and rain, and a wide round doorway in the outer side. A few mornings later she lays the first of the white eggs wreathed with brownish spots, then two or three more on the following days. Now is the time for the striped flycatchers to put in their master stroke of strategy. It is not without a purpose that they have waited all these weeks in the tops of neighboring trees, appearing so blithe and innocent, yet watching every move of their intended victims, and quite aware of the precise stage of the nesting operations of the particular gray-cap or chipsacheery they have chosen as their dupe.

One fine morning, after the eggs have been laid in the domed nest, one of the striped pair ventures closer than the owners will permit. Then one of the yellow-breasted owners, as likely as not the male, darts at the intruder, who at once prudently retires. Perhaps the female yellow-breast joins in the aerial chase. The longer and hotter the pursuit, the better for the purposes of the striped flycatchers. While one of the pair decoys the owners away, the other enters the unguarded nest, takes a spotted egg in its bill, flies out and drops it to the ground. They have scored their first point in the unequal contest. Then they go off a while, insect catching and calling, and at their convenience return for the second round. The yellow-breasted owners of the nest, excited and angry now, dart fiercely at them, determined to drive away these impertinent thieves. The chase is hot, pursuer and pursued twist and double until it is difficult to follow their movements with the eye. But the defense of the yellow-breasts reveals more zeal than strategy; in their spirited sally to drive the trespassers away from their citadel, they have neglected to maintain a garrison. Again the striped birds' opportunity arrives and soon a second egg lies broken on the ground. When the last of the three or four eggs has shared the same fate, the contest ends, as it always does, in favor of the striped flycatchers. Although the battle was spectacular and noisy, with both sides voicing their characteristic cries, none of the contestants suffered personal injury greater than the loss of a few feathers.

Few birds will lay a second time in a nest that has been pillaged. So the gray-cap or chipsacheery who has lost her nest soon begins, hopeful and industrious as ever, to construct a second domed nest close by, leaving the plundered structure in possession of the invaders. These carry in a loose handful of small dry leaves—which the builders of these domed nests never themselves take in—as though they felt constrained to make at least a pretense of useful effort. Among this loose litter the female striped flycatcher lays her three grayish-brown, mottled eggs, and incubates them while her mate whistles in impudent exultation from the nearest treetop. And these thieving birds, once established in their ill-gotten home, guard it with as much zeal, and attend with as much care and affection the eggs and young it shelters, as though they had built it with their own bills. Frequently the female may be overheard singing to herself a sweet little song of love and contentment as she sits over her eggs.

The season is now well advanced, and the dispossessed yellow-breast labors with more concentrated energy to finish her second nest. Soon it is completed, a new set of eggs deposited in it, and the patient task of incubation begun once again. Occasionally, during an interval when the second nest of its victims remains unguarded, a striped flycatcher will remove an egg from that nest; more from

habit than from malice. But in general, all goes well with the replacement nest of the yellow-breasts—provided snake and weasel and hawk and destructive boys fail to pass its way—so long as the striped flycatchers prosper in their stolen nest near by. But the eggs and young of the home-robbers are preyed upon by the same enemies that take toll of the offspring of the home-builders. If they are lost, as may happen in from a quarter to a half of all the nests occupied by the striped flycatchers, they will not again entrust their eggs to the structure that has been once pillaged. Instead, they demand another commodious domed nest of their dupes, the yellow-breasts, and will most likely throw out the new set of eggs that the female yellow-breast is incubating in her second structure near by, causing the unfortunate bird to build yet a third. One might suppose that the unhappy pair would withdraw to some more distant locality to construct their later nests, instead of placing them within such easy reach of their persecutors and despoilers. But as a rule, this is not feasible; were they to go in search of another area suitable for their breeding operations, in all likelihood they would find it already in possession of another pair of their kind, who would resent their intrusion, and who most probably had also to contend with a pair of the pestiferous stripe-breasts. So the long-suffering gray-caps and chipsacheeries linger upon their own home ground chosen many months before, and hopefully build nest after nest there, until at length, unless they have more than usual bad luck, one is successful, and their bright-eyed fledglings, safely past the most critical period of their lives, fly from its shelter, and clamor incessantly for food in the neighboring trees.

Thus, when a pair of the yellow-breasted flycatchers is selected by a pair of striped flycatchers as their victims, they not only lose their first nest but may lose their subsequent nests. Consequently, *their success depends to a large extent upon the success of their persecutors.* The safety of the second nest occupied by their eggs and nestlings is not bound up in this nest alone, but also in the earlier structure stolen from them by the striped flycatchers, and the risk of loss is doubled. Fortunately, the chipsacheery and gray-capped flycatchers are hardy, prolific species, widespread in tropical America. The striped flycatcher, like the chipsacheery (the wider-ranging of its victims), spreads over a vast territory stretching from Mexico to the northern districts of the Argentine Republic, but in most parts of its range is far less abundant than the two yellow-breasted species whose nests it occupies. And these, despite the loss of so many nests to the striped thief, are in extensive regions of the American tropics among the most abundant and familiar of birds about the dooryards of men, in pastures with scattered trees, and along the shores of rivers and lakes. They avoid the heavy, unbroken forests where conditions are not favorable for their flycatching.

II

Here Nature herself has created a situation that points as profound a moral as any parable sprung from the fecund imagination of Aesop, La Fontaine, or Iriarte. Of the main events in the struggle between the striped flycatcher and its victims I am perfectly sure, having witnessed it not fifty yards from my dwelling. And each year, over a vast territory in the warmer countries of America, this little drama of bird life is acted many thousands of times over; as it has been, no doubt, during untold centuries stretching beyond the dawn of human history. Here is a relationship between two antagonistic species so old, so firmly established, and so widespread, that it may well be worthy of our serious examination. The reader, if he is acquainted with none of the chief protagonists—if he has never heard the long-continued dawn-song from which the chipsacheery flycatcher takes its name, and has seen nothing of the devoted industry of the gray-cap as she fashions her domed nest—will have formed no prejudices in favor of one side or the other, and can the more dispassionately and unerringly draw conclusions from their strange history.

For I, after long acquaintance with these attractive birds, have become the partisan of the aggrieved party. Once, while witnessing the conflict between a pair of gray-caps and a pair of striped flycatchers for the possession of the former's nest, I longed to be able

to drop a word of advice into the ear of the defenders. "Instead of dashing foolishly in pursuit of your slippery assailants," I wanted to tell them, "keep your citadel constantly garrisoned. Take turns at warming your eggs, keep them constantly covered and the pesky little stripe-breasts will never be able to harm them."

But I fear that this would have been advice proffered in vain. In all the great family of the American flycatchers, I have not, in years of study, discovered a single species of which the male takes a turn on the eggs. For a male flycatcher to sit in the nest would be as preposterous and unconventional as for a male woodpecker or a male antbird to fail to take his full share in warming the eggs and brooding the young. Being conservative by nature, doubtless the gray-caps would rather continue to risk the loss of their nests, than to change the age-old customs of their kind; just as those who have been born and raised upon the slopes of a volcano will linger there, under the constant menace of a disastrous eruption, rather than seek a safer home in strange parts.

What, then, could the gray-capped flycatchers and the chipsacheeries do to put an end to this annually recurrent and oft-repeated outrage? Here is a problem that has sometimes amused me upon my solitary walks. They might unite against their tormentors and attempt to make an end of them in an active war of extermination. But in this it is not likely that they would be successful; for the striped flycatchers, although smaller and weaker, are sufficiently swift and agile to elude their pursuers. Or they might become disciples of the Mahatma Gandhi, wage a passive rather than an active warfare, and refuse to build nests at all, seeing that so large a proportion of them are made for the use of others. But this Gandhian policy, also, could not be wholly successful; for the two species of yellow-breasted flycatchers, although the chief victims of the striped-breasts, are by no means the only ones. The nest-thieves occupy a considerable variety of covered or closed nests, including the long, woven pouches of the oropéndolas and other members of the oriole family, the snug globular structures of fibrous and downy materials built in the tree-tops by becards, and have even been known to take possession of the nest-chamber carved by gartered trogons into the heart of a big, papery wasps' nest. It is probably in such situations that their litter of dead leaves is of service, for trogons do not line their nests with soft materials. But there is no record of the striped flycatchers' ever having made use of an open nest, such as those of thrushes, tanagers, sparrows, and the great majority of songbirds. Hence, were the yellow-breasted flycatchers to go on strike and refuse to build, the striped flycatchers would be deprived of the most important, but by no means the only, source of their nests. By such a course, the yellow-breasts would be more likely to accomplish race-suicide than the extermination of their enemies.

Or, taking the philanthropic—or should it be philornithic?—view, the chipsacheeries and gray-caps might establish schools to teach the less gifted striped flycatchers how to build their nests. But in such a high-minded endeavor, the auguries of success are not encouraging. Students of evolution have crystallized certain of their conclusions in the so-called "Law of Loss." They have discovered that when once an organism, in the course of many generations of evolutionary change, loses an organ, that organ is never recovered. If, as a result of secular changes in environment, external conditions recreate the need for the lost part, it is not reconstituted in its primitive form, but at best a substitute is gradually developed. Thus plants of a number of kinds, at home in arid regions, have little by little quite lost their leaves. When one of these plants again finds itself growing under humid conditions where the possession of broadly expanded leaves would be an advantage, it cannot recover its lost foliage in the original form, but at best, during the course of many generations, develops substitutes of quite distinct origin, such as flatly expanded stems or leaf-stalks. What applies to organs probably holds equally true of instincts, such as that of nest-building. As well attempt to help a snake sprout forth again the legs enjoyed by its remote ancestors, as to teach a striped flycatcher to fashion a nest such as its forefathers once built.

All things considered, it is probable that

the best course the victims of the striped flycatchers could take is that which they already follow. Indeed, it is not likely that the philosophic naturalist, in his comfortable armchair or on his musing evening walks, can improve upon the ways Nature has developed as the result of countless millions of trials covering many thousands of years. Yet I make bold to suggest an improvement, in one small point, on the course actually followed by the yellow-breasted flycatchers: that instead of making a nest in the vain hope of using it themselves and laying eggs only to have them thrown away, each pair of yellow-breasts, at the outset of the breeding season, build a nest especially for the pair of striped flycatchers that has attached itself to them, and when it is completed, lay no eggs there, but respectfully invite their persecutors to move in and have joy of it. Then, chirping praises of their own philornithy in providing their poor relations with the means to perpetuate their kind, they can go ahead and build another for themselves, with better prospects of remaining in possession. But let them fashion the nest intended for the striped flycatchers with all the care they bestow upon that destined for their own offspring; for if the first is flimsily built and collapses in a rainstorm, the tenants will, as I once saw, abandon it, and dispossess the yellow-breasts of their more sturdily built second nest. And let the graycaps and chipsacheeries wish success to those for whom they have built; although they may not love those clamorous, improvident creatures, they have every reason to wish them good fortune, knowing full well that any mishap that befalls the striped-breasts' nests will be also their own misfortune. For the prosperity of the highly gifted yellow-breasted flycatchers is linked with the welfare of the deficient striped-breasts.

III

Our study of a certain peculiar situation existing among the birds of tropical America has led to the quite unexpected conclusion that the best course certain persecuted species can follow is, if not to love, at least to wish well to a second species as a result of whose deficiencies they are grievously annoyed. Nature herself, Nature "red in tooth and claw," has taught, in this instance at least, a rule of conduct closely approximating some of the doctrines of Christ often looked upon as fantastically idealistic and quite inapplicable to conditions as they actually exist in this world of conflict and brute force. To love their enemies, to turn the other cheek in the figurative sense, is the course of action which will bring the yellow-breasted flycatchers the maximum of success in their endeavor to reproduce their kind, with the least amount of annoyance. And this is, in effect, the course they actually follow, with cries of wrath and unchristian complaints, no doubt, yet with no great resistance. I have never known a yellow-breasted flycatcher to try to settle accounts with the despoiler of its nest by vengefully throwing out the intruder's eggs—an act which, as we have seen, would only redound to its own further loss.

One lesson more may be drawn from this strange situation. We commonly assume that the strongest, the most perfectly equipped species, will be most successful in the struggle for existence. But this is by no means universally true. Some organisms are eminently successful by virtue of their very weaknesses. The striped flycatchers, with their grave deficiencies of instinct, lord it over the obviously better equipped yellow-breasted flycatchers, which to our eyes are a "nobler" species. Seeds of a vine and a great tree germinate side by side in the dim light of the forest floor. The light-starved tree seedling grows with extreme slowness; it must form a self-supporting trunk as it increases in stature, and can never mature and fructify unless one of the giant trees above fall and make an opening in the high canopy where it can spread its ample limbs and enjoy the full sunlight. But there will be many competitors for this gap when at length it occurs; and the seedling's chances of ultimate success are exceedingly slender. But the vine, which will never be able to hold itself erect, twines slowly upward from limb to limb and from tree to tree, until at last it spreads a tangled maze over the loftiest of them all, and displays its brilliant blossoms over the roof of the forest. Its very lack of a self-supporting stem contributes to its suc-

cess; the necessity to form one, to complete itself, causes the failure of the seedling tree.

IV

The problem of the striped flycatcher is not confined to the bird world alone; it is of far broader significance. Striped flycatchers we have always with us. In human society they are the underprivileged, the disinherited, the inept. But the advantage of considering the problem as it occurs among birds is that we can do so dispassionately, and so reach truer conclusions. Human problems are so bound up with our fears, hopes, and prejudices that only with difficulty can we give them the detached, objective consideration essential for reaching solid conclusions about our social behavior.

In the tropical valley where I dwell, the welfare of two highly endowed species of birds is intimately dependent upon that of a third species with a conspicuous deficiency which—without justification, as we see it—makes a claim upon their superior endowments. The security of their homes and families hangs upon the safety of the homes wrested from them by their poor relations. The happiness of some of the noblest birds in the valley is linked with that of one which, from the point of view of the human moralist, is the most ignoble of them all.

Is it otherwise in human communities? I think not. In a hundred ways, some direct, some subtle and tortuous, the welfare and happiness of the ablest and most gifted members of a society are dependent upon that of the poorest, the meanest, the most defective—the striped flycatchers among us. The diseases that breed in the slums and the shacks of the indigent find their victims at length in the comfortable homes of the prosperous. The vices which lurk there creep into the well-ordered families of the substantial citizens. The thieves created by idleness and destitution take toll of the goods of the well-accommodated. If the underprivileged class is sufficiently numerous, then the political and economic systems of the country are disordered, the entire moral atmosphere polluted. Longer-suffering than their feathered prototypes, restrained by law, custom, and the whole ponderous superstructure of the social system, the human striped flycatchers do not assert their fundamental needs with such salutary regularity. But if their deficiencies become too acute, their sufferings too dire, they rise up with energy and wrath that shake the whole social order to its foundations and strike down the lords of the land.

But in ways still more subtle and immaterial, our happiness is influenced by even the least of the creatures around us. Sensitive persons are peculiarly affected by the proximity of suffering and distress. The sight of a crippled beggar, a mistreated child, a fly-tortured horse, a broken-winged bird, or even a mutilated butterfly, casts its shadow of melancholy, large or small, over the sunlit fields of the fairest morning. Those who know how to live well try to surround themselves with creatures in good health and fine spirits. The raw-boned horse and the woebegone dog are not found in the possession of sensitive people.

The psychology of happiness has never been fully analyzed. How is it that great catastrophes, such as wars, plagues, and earthquakes, throw a cloud of unhappiness, proportioned to their magnitude, over persons far removed from actual contact with them, hardly affected even by their indirect consequences? By what mystic bonds of sympathy, what obscure telepathy of suffering, does this action at a distance occur? Perhaps, in some fashion we fail to understand, all suffering, whether of man or other living creatures, no matter how remote, exerts its proportioned influence upon our spirits and prevents our happiness from attaining its fullest measure. Perhaps none will ever enjoy full, unruffled beatitude until—O, when?—misery and pain quite vanish from the earth.

In smaller spheres of action, the dependence of our well-being upon that of the creatures around us is becoming increasingly evident to thoughtful men. The farmer who applies the doctrine of "cure or kill" to his suffering domestic animals has taken the first step in the practical application of this philosophy. Only savage, insensitive natures can endure to be surrounded by maimed, suffering, or mistreated animals. The same applies with added force to our own kind. The degree of civilization of a community or a nation may be gauged by its effort to educate the underprivileged, that they may create for themselves the things they need

for the completion of their lives, for their happiness. In all enlightened countries, the congenitally defective and inept—those true striped flycatchers that can never be taught to build their own nests—are supported by public charity or kept in appropriate institutions. These benefactions in favor of the underprivileged are a huge drain upon the resources of the community; but wise administrators and thoughtful citizens do not doubt the wisdom of making the sacrifice, just as the yellow-breasted flycatchers have learned, under Nature's wise tutelage, to give up their nests to the striped-breasts without too much resistance and with no revengeful reprisals. Peace and harmony are bought only at the expense of giving the unendowed their vital needs or by exterminating them. A few modern states, unshackled by tradition or by compassion, have attempted the eradication of their striped-breast class. The wisdom and the practicability of this policy remain to be proved.

V

Logically, it requires but a short step to apply to the family of nations the parable that points so plain a lesson in situations where selfishness and prejudice do not blind us to its truth. Yet in practice it is a step so long that only a few of the most far-sighted of statesmen have been able to take it. From the example of Nature, as from civic experience, we have learned that where a striped-breast class exists, peace and security can be attained by either of two methods: by its extirpation or by yielding to its necessities with the best grace we are capable of assuming. The rule still holds when we turn from birds and men as individuals to those aggregations of men called nations.

An underprivileged nation is one poor in natural resources, or with insufficient territory for its population, or with position and empire inferior to that which the ability of its people entitle it to hold. Add to these that most dangerous class of all: nations intellectually or temperamentally unfitted for self-government. All such countries must sooner or later come into armed conflict with their better endowed neighbors. Perhaps, now that the days of dynastic wars are gone, and the world has ceased to be a chessboard over which rival princes play for fiefs and vassals, it would not be far from truth to state that only such countries fight with their neighbors. For like the striped flycatcher, like the underprivileged classes in the social structure, no nation will long rest quiet without the things it needs for continued existence. It will not succumb without a death-struggle.

When a population of birds, or a community of men, has learned that the welfare and stability of the group can best be maintained by submitting to sacrifices in behalf of the underprivileged and handicapped individuals, it appears to follow that the general health of the family of nations can best be secured by a like policy. Those countries on the west coast of South America whose territory extends across the Andes possess large areas with no natural outlet save by way of the Amazon River, flowing for two thousand miles through territory undisputedly Brazilian. Years ago, Brazil declared the great river open to international navigation, when she might have kept it closed with lucrative tariffs, and as a result the largest country in South America lives in unruffled amity with her neighbors to the west. The great nation of Poland was, in a sense, in much the same situation as the vast but thinly populated Oriente of Peru; it could obtain access to the sea and free international commerce only through foreign territory. The "Polish Corridor," so important to the nation it served, without doubt caused inconvenience to the Germans whose territorial continuity it severed. Less liberal than Brazil, Germany would not abide this inevitable annoyance; and Poland's outlet to the oceans became one of the causes leading to universal conflict.

Peace will reign only when nations learn to make sacrifices to preserve it, to abide with good-humored patience inconveniences which arise from unavoidable international difficulties, and to feel an obligation toward neighboring countries less fortunate than themselves—in short, when they learn to act generously instead of selfishly. Alas! it seems that nations must ever be less noble than many of the men who compose them. Individuals have not infrequently been known to perform acts of spontaneous generosity; nations, almost never. Individuals have times without number made sacrifices—

even the highest sacrifice—for the public good. When has a nation spontaneously made a genuine sacrifice for the good of mankind? National honor is far inferior to the best individual honor, so-called "national honor" being a species of arrogant, swaggering pride, rather than a scrupulous care in the performance of obligations. No prudent man would care to do business with an individual or firm that could produce no better record of the fulfillment of contracts than the majority of nations have shown throughout history.

It is as imprudent for a country of great wealth, culture, and resources to allow itself to be surrounded by rude, impoverished neighbors, as for a rich man to live among starving paupers. The rich man, if wise and farsighted, will increase his security, and probably also his wealth, by helping his neighbors to earn an adequate living. But there may come times when he is called upon to give them bread to protect himself.

But with certain nations, diseased by greed or intoxicated with delusions of their own grandeur, no degree of generosity, no amount of graceful yielding, can bring peace and conciliation. Such countries no longer struggle for the means of existence; they are content only with domination. What nation could have yielded to the demands of the Persia of Darius, the Macedonia of Alexander, or the France of Napoleon, and continued to exist? Carthage and Rome, as two states whose pride and ambition had no bounds, were well equipped to understand each other. Their statesmen knew that conciliation was impossible and no peace between them could be lasting, because neither could brook any limit to its power. It is as though the striped flycatchers, not content with the single nest they must have or fail to reproduce their kind, believed that their noble qualities entitled them to every nest the yellow-breasted flycatchers could build; then for the yellow-breasts there would be no middle course between destroying the striped flycatchers and being destroyed by them.

ALEXANDER F. SKUTCH—NATURALIST

DR. SKUTCH was born in Baltimore, Maryland, in 1904. His formal education was obtained in Baltimore, first in private schools and then at Johns Hopkins where he received his doctorate in botany in 1928. His own story follows: During my undergraduate years, I spent the summers on Mt. Desert Island, Maine, studying the northern plant-life, especially that of the seashore. During the summer of 1926, I enjoyed my first glimpse of the tropics, on a botanical expedition to the island of Jamaica. Here we stayed for six weeks in the Blue Mountains. After the return of the party, I settled down for six weeks more on a banana plantation to make a study of the anatomy of the banana leaf for the United Fruit Company—this became my doctor's dissertation.

In 1928 I went to Almirante in western Panama on a fellowship from Hopkins to continue my studies of the banana at the research station the United Fruit Company then maintained there. In 1930 I continued these studies at Tela, Honduras. Upon these visits to Central America, I became deeply interested in the bird-life. I found that the birds of this region had all been classified, but exceedingly little was known about how they lived. I resolved to dedicate myself to this study. In 1932 I spent half a year on a banana plantation on the border between Guatemala and Honduras, making an independent study of the birds. I spent all the following year studying the birds of the Guatemalan highlands at elevations ranging from 7,000 to 10,000 feet and here I also made a collection of the plants. This led to a commission from the Arnold Arboretum of Harvard University to collect for them during the following year in the Guatemalan highlands.

In 1935 I came to Costa Rica, with plans to combine my studies of the birds with botanical collecting as a means of support. Hearing much about the Valley of El General, I resolved to go there. I found a pioneer community, with unspoiled forests on the very outskirts of the principal village. The local *Jefe Politico* was most helpful; through him I acquired a cabin with a thatched roof in Rivas, where I dwelt for a year and a half—thrice the length of my intended visit. Later I spent two more seasons in natural history work in other parts of the valley.

At the beginning of 1940, I accepted the post of curator of the herbarium in the Museo Nacional in San José, but resigned after six months to go to Peru, Ecuador, and Colombia on a rubber survey party for the U. S. Department of Agriculture.

Having come to look upon the Valley of El General as home, I returned in 1941 and bought a farm of fifty hectares (about 125 acres), so newly carved from the forest that the pastures are even now littered with logs and stumps. Here I have been living since then, doing subsistence farming —keeping sufficient horses and cattle for the work of the farm. All the time the farm work allows—a good deal in the wet season—I devote to studying the wild-life and to writing.

METEOROLOGICAL MILEPOSTS

By HARVEY A. ZINSZER

METEOROLOGY (meteora + logos), the science of things supraterrestrial, began with the observations of primitive peoples whose outdoor occupations of hunting, tending flocks, and cultivating the soil depended greatly upon the weather. Some of the earliest writings extant contain fragmentary references to weather phenomena. For example, *Job*, supposedly written in 1520 B.C., and *Ecclesiastes*, written about 977 B.C., both contain speculations regarding the weather, some of which are believed to have been old even at the time of their recording. The weather rule which taught that the first twelve days of the year indicated the type of weather for each of the ensuing months was traced back by Hellmann to the fifteenth century B.C. The ancient Chaldeans and Babylonians, pioneers in the science of astronomy, tried to connect the phenomena of weather with the motions of the heavenly bodies. The Greeks, too, were forerunners in the field of meteorology, for in Athens today there stands the Temple of the Winds, an edifice erected about 100 B.C. for observing the direction of the winds. It is an octagonal tower constructed of marble, and at the top of each face is a sculptured figure of one of the winds.

However, the earliest known effort at a systematic discussion of meteorology was the *Meteorologica* of Aristotle (384–322 B.C.), which was the standard work for two thousand years. About 400 B.C. Hippocrates, the Father of Medicine, wrote the first treatise on medical climatology with many interesting inferences; while Theophrastus, a pupil of Aristotle, wrote treatises on winds and weather signs. It is also known that in India rain measurements were made as early as the fourth century B.C. and that wind vanes were used in the first century B.C.

Perhaps the first meteorological instrument with a reacting substance was the hygroscope of Cardinal de Cusa (1401–1464) for determining humidity by weighing balls of wool under various moisture conditions. In about 1500, Leonardo da Vinci constructed an improved wind vane and a mechanical moisture indicator. The period of exact weather observations had its beginning in about 1590 with the invention of the thermometer by Galileo and Sanctorius of Padua. In 1643, Torricelli, a pupil of Galileo, invented the barometer known as "Torricelli's tube." Five years later, Pascal persuaded his brother-in-law, Perrier, who lived near Puy-de-Dome, a mountain in southern France, to ascend the mountain to determine whether the height of the mercury column in the barometer would diminish with altitude. Perrier's observations disproved the old belief that "nature abhors a vacuum," and showed conclusively that atmospheric pressure diminishes with altitude.

The transition from visual to instrumental observations, or rather the movement toward exactitude in the field of meteorology, was attended by a long series of discoveries and inventions. Pendulum anemometers for measuring the force of the wind were erected in Bologna and in Florence by the astronomer Egnatio Danti, about 1570. The Italians also developed the rain gauge, which was first used by Beneditto Castelli. Other discoveries contributing to the science of meteorology were: the condensation hygrometer for measuring moisture in the atmosphere, by Ferdinand II of Tuscany in 1650; the law of "the Spring of the Air," discovered in 1660 by Robert Boyle and later named after him; the meteorograph, by Wren in 1664; the introduction of the freezing point and boiling point of water as reference points on the thermometric scale, by Huyghens in 1665; the Fahrenheit scale in 1710; the hair hygrometer, by de Saussure in 1783 (de Saussure also showed that damp air is lighter than dry air at the same temperature and pressure); the wind force scale, by Admiral Beaufort in 1805; the psychrometer by August in 1825; the pyrheliometer for measuring the sun's heat, by Pouillet in 1837; the aneroid barometer, by Vidie in 1847; culminating with the perfecting of the radiosonde (radiometeorograph) for radioing from aloft values of atmospheric tempera-

ture, pressure, and relative humidity, by Diamond and Hinman of the Bureau of Standards in 1936.

Since winds were obviously of paramount importance in the era of sailing vessels, we find von Verulam announcing, in 1624, the rotation of the winds with the sun; while in 1686, Halley gave the first account of the trade winds and the monsoons. Thus was attention soon directed to such traveling disturbances as cyclones and tropical storms. Already in 1687, Dampier recognized typhoons as revolving storms; this was also found to be true of cyclones by Brandes in 1820, and of hurricanes by Redfield in 1840. Perhaps the most significant discovery of this kind was that of Franklin in 1747 when he found from but two observation points that the local weather may be a small part of a meteorological configuration passing over the country. Franklin had planned to observe an eclipse of the moon in Philadelphia; he wrote his brother in Boston requesting him to make similar observations from there. On the day of the eclipse it was stormy in Philadelphia with rain from the northeast. Franklin learned later, and to his surprise, that it was clear in Boston at the time of the eclipse but that soon thereafter a northeast rain occurred. Hence he discovered that though the rain as it fell appeared to come from the northeast, the storm actually traveled northeast from Philadelphia to Boston.

The study of heat and thermodynamics which underwent a considerable development in the first half of the nineteenth century contributed much to the science of meteorology. Watt had invented the steam engine in 1765, and Lavoisier had established the true nature of the atmosphere in 1783. The law of partial pressures pertaining to a mixture of gases was given by Dalton in 1800, thus making it possible to determine the individual pressure of water vapor in the atmosphere. Dalton also wrote an epoch-making paper on the effects of rarefaction and condensation, which laid the foundation of modern physical meteorology. Carnot's book, *Réflexions sur la puissance motrice du feu,* written in 1826, introduced the so-called Motor Age leading to modern transportation and present-day aviation with its profound influence on meteorology. In 1830, James P. Espy announced the important principle of the cooling of air as it rose and expanded, and in 1841 he published his *Philosophy of Storms* in which he stated the importance of the expansion of rising air in the formation of thunderstorms and clouds. Almost simultaneously, Dove published his theory of storms with indications that storms originate when polar air and tropical air are brought into juxtaposition. This was followed in 1856 by Ferrel's theory of general circulation in which, by the application of dynamic theory, he showed the effects of the earth's rotation on a mass of moving air.

While the observations of Tycho Brahe from 1582 to 1598 comprise the earliest systematic meteorological records, we find the Chevalier de Lamarck (1774–1829) working with Laplace, Lavoisier, and others in establishing a network of observing stations, and publishing a series of *Annuaires Météorologiques* from 1800 to 1815. The earliest record of synoptic weather charts is, however, accredited to Brandes who, in 1820, produced a series of daily weather charts, one for each day of the year 1783, and who later published charts of the great storms of 1820, 1821, and 1823. He explained these storms as due to barometric depressions advancing from west to east over the earth's surface.

In America, Espy carried out similar researches; he established a service of daily synchronous observations and studied in detail the behavior of depressions. The work of Lamarck, Brandes, Espy, and others led to the establishment of networks of meteorological stations in several countries within the years of 1850–1856, the Meteorological Office in London having been set up in 1854. International cooperation was first established by an international conference held in Brussels in 1853, and was put on a sound basis by an international congress in Vienna in 1873. Meanwhile, in 1860, Buys-Ballot announced the so-called baric wind law which states the relation between wind and pressure distribution; namely, if the wind is to your back, the pressure is lower on your left than on your right in the Northern Hemisphere; and oppositely for the Southern Hemisphere. The first map of pressure distribution over the entire world was produced

by Buchan in 1869; it was followed by Mohn's storm atlas in 1870.

An interesting sidelight influencing the advent of weather maps occurred during the Crimean War (1854–1856), when a storm in the Black Sea caused considerable damage to the French fleet, especially to the battleship Henri IV. About this time, the astronomer Leverrier had won world renown by forecasting the existence of a new planet. Napoleon III apparently thought that if science could predict the whereabouts of hitherto unknown planets it could also forecast storms and weather. He therefore charged Leverrier with the difficult task of organizing a system of weather forecasting. Since there were no weather bureaus or organized system of reporting, Leverrier had to call upon observatories, universities, and a few observing stations that kept meteorological logs for data. From this material he plotted primitive weather maps by means of which a "post mortem" study of the Black Sea storm could be made. He found that the storm could be traced from one weather map to another and that it moved along a regular path and with fairly constant speed. The conclusion drawn was that if observations were made at a large number of stations and if reports could be transmitted with sufficient speed to a central office, one could by plotting and by analysis extrapolate a storm's future movement.

Naturally these results created a wave of enthusiasm, and the second half of the century saw weather bureaus established in several of the civilized countries of the globe. However, it was soon found that the problem of forecasting was more intricate than anticipated. Since at this time little was known of the normal state of the atmosphere, it was difficult to understand the perturbations superimposed upon it. The methods of forecasting were based mostly on statistics and rules of thumb, which were generally of local or regional value only. So the optimism created by Leverrier's report was soon followed by a period of dormancy which prevailed more or less until World War I when the problem of weather forecasting was attacked with renewed vigor and determination. In fact, the development of aviation since World War I has provided a greater stimulus for a rebirth of meteorology than the entire previous history of man.

In the United States, Professor Cleveland Abbe, Director of the Observatory in Cincinnati, with the assistance of the Western Union Telegraph Company, undertook, in 1869, to gather data and forecast storms. The results were so uniformly successful that the organization of the Weather Service as part of the Signal Service under the War Department occurred the following year. In 1891 the Weather Service was made a separate bureau and placed under the Department of Agriculture; and, under the able leadership of men like Harrington, Moore, Marvin, and Gregg, has been efficiently gathering data from hundreds of stations over the United States, analyzing it, and broadcasting the results in but a few hours. By authority of the Air Commerce Act of 1926 and the Civil Aeronautics Act of 1938, the Weather Bureau is today charged with the responsibility of furnishing an adequate meteorological service for aviation in order "to promote the safety and efficiency of air navigation in the United States and above the high seas."

In constantly endeavoring to maintain as complete a service as possible, the Weather Bureau has established about 550 stations at fairly regular distances apart along the civil airways in the United States, Alaska, and Hawaii; and, in addition, over 250 stations rather uniformly distributed off the airways for reporting weather. Reports are collected by teletype and radio from airway stations, and by telegraph and telephone from off-airway stations. These reports are then relayed to required points along the airways by the Department of Commerce radio and teletype systems. About 140 of the foregoing meteorological stations are equipped for taking upper-air wind observations by means of pilot balloons; while approximately thirty stations are equipped for taking radiosonde observations in which instruments carried aloft by balloons report conditions of temperature, pressure, and humidity by means of radio. At about 150 important airway terminals, qualified meteorologists of the Weather Bureau are on duty twenty-four hours a day, charting and analyzing

weather reports and discussing the meteorological conditions with pilots of the airlines.

In the past, almost all the observations used in the forecasting of weather were taken at or near the earth's surface, little use being made of observations taken at high altitudes. In recent years, however, upper air conditions and movements have been studied, and as a result changes have been made in the theory of formation and structure of cyclonic storms. The polar front theory of the formation of cyclones and the method of air mass analysis used in forecasting weather conditions were developed largely by the Norwegian school of meteorologists.

Since upper air analysis, so important in weather forecasting, is contingent upon meteorological information concerning the upper air, a brief sketch of the development of this phase of the science seems apropos. The first scientific balloon ascent was made in Paris by Charles in about 1803. Other ascents were made by Glaisher from 1862 to 1866. From 1890 on, sundry mountain observatories were erected to record the various meteorological conditions of the free atmosphere; in the United States, the pioneer mountain observatories were set up on Mount Washington and on Pikes Peak. Balloons and kites carrying instruments were also used with increasing frequency to obtain observations from the upper atmosphere. In 1901, Suring and Berson reached an altitude of 35,400 feet in a free balloon. A year later, Teisserenc de Bort and Assmann discovered the stratosphere; and, shortly thereafter, Gold and Humphreys gave a theoretical explanation for the formation of the tropopause. However, simultaneous observations from the free atmosphere in large numbers and over large areas were obtainable only after the airplane and the radio came into general use. The findings of Stevens and Anderson, who in 1935 ascended to a height of 72,395 feet above sea-level in the Explorer II, added considerably to the fund of knowledge in meteorology.

The vast uninhabited regions in the arctic and the antarctic were tempting fields for exploration, and much information was brought home by numerous polar expeditions to enhance our steadily growing knowledge of polar meteorology, a typical example being the work of Admiral Byrd at Little America. Another feature of considerable interest in meteorology are the early ideas of wave motion in the atmosphere promulgated by Helmholtz and modified later by Solberg in 1928. Perhaps the most outstanding achievements of the past quarter century in this field are the discovery of the polar front, the wave theory of cyclones, the air-mass and frontal methods of weather forecasting initiated by V. Bjerknes and his collaborators in Norway; and the method of isentropic analysis as initiated by Rossby and his collaborators in the United States.

A sense of accomplishment and genuine satisfaction attend the learning of the vagaries and reasons for the weather, for one of the most fascinating phases of knowledge lies in the ability to answer the question "why" with regard to natural phenomena.

Although the application of the use of expert meteorological prognostication in the present war should probably not be discussed in special detail for the duration, after the war an important chapter on this phase will undoubtedly be written revealing the remarkable happenings in this field.

SCIENCE WITHOUT EXPERIMENT: A STUDY OF DESCARTES

By RUFUS SUTER

A FEW years ago Greta Garbo in the role of Queen Christine spoke of the Frenchman, René Descartes (1596–1650). This was one of the few times the name of a professional thinker has been mentioned on the screen; but if Descartes could have heard he might have been sad, for his few months as tutor to that royal lover of the strenuous life ended in his death. The scholar, who for years had been used to his bed until afternoon, could not withstand the rigors of a horseback ride at sunrise, which was the Queen's idea of the proper setting for a philosophic lecture.

There is propriety in remembering Descartes in the aura of a Garbo play. Some quaint shots could be made of the philosopher as a young soldier on the Danube in the service of the Duke of Bavaria, Maximilian. This was the beginning of the Thirty Years War, so notorious for its cruelties and religious fanaticism, though for Descartes little of the morbid side of the military life was evident. His time was spent in mathematical discussion with army engineers. One wonders how a soldier could have avoided so successfully the harsher experiences of war. But Descartes had the ability to take his ease in spite of environment, at any rate until he visited Queen Christine.

A picturesque shot could be made of the soldier snowbound for a day while returning to the army from Frankfurt where he had watched the coronation of the Holy Roman Emperor, Ferdinand. Alone and seated by a stove he made his discovery of the basis of true science, as the climax of a period of dreams and religious exaltation. He suggests Buddha sitting under the Bo tree rather than his Italian contemporary, Galileo, who laid bare the basis of science while measuring the speed of balls rolling down an inclined plane.

The most romantic feature about Descartes, however, is that in the hut near Frankfurt he discovered a scientific method which is not the one we know at present.

It requires effort for us today to understand a technique in physics, chemistry, or the like, other than that of experiment and observation. The effort is hardly less than that needed to conceive of a non-Pythagorean arithmetic or a non-Euclidean geometry. We will find it worthwhile, nevertheless, to recapture the technique of Descartes, because an understanding of why it failed will help in the appreciation of why the more prosaic technique of the master mechanic, Galileo, succeeded.

Before looking at his method we must pay attention to the historical circumstances in which it was born. We must guard against reading our acceptance of the experimental method into the minds of the first two or three generations of scientists; against picturing them as single-mindedly loyal to the principle of experiment in their revolt against the ancient teachings of Aristotle in the schools, churches, and learned communities of Europe. Although the fathers of modern science were at one in their struggle to dislodge the arid expositors of Aristotle, the fact is that like many another revolutionary party their unanimity stopped with their agreement about their common enemy. Otherwise they fought among themselves. After the foe had been overcome, several generations were needed to liquidate the right wing, of which Descartes was the leader. Only then did the left wing, the familiar succession of Galileo, Boyle, Newton, and Watt, have the chance to accomplish its mission.

To be more specific: struggling to dislodge the expositors of Aristotle were, on the one hand, men later known in the history of ideas as the empiricists, from the Greek ἐμπειρία, meaning "experience," and ultimately from πεῖρα, a "trial," suggesting that knowledge is the fruit of trial and error in the handling of the familiar things of everyday life. This technique, among speculators about the sources and limits of knowledge, eventually became refined so that the scientists themselves who used it would not

have recognized it. In its cruder form, however, in which it has been wielded for ages by artisans and engineers, and by the most inventive of the early modern experimenters, Galileo, it was practical and it acted as a bombshell in the camp of the Aristotelians.

On the other hand, there were the defenders of the new rationalism (from *ratio,* "reason") of whom Descartes was the inspiring genius. The word "new" is used significantly because the Aristotelians, entrenched in the churches and colleges, whatever may have been their failings, were themselves defenders of reason. To them, indeed, empiricist and new rationalist alike owed the ideal of consistency. But the scholastic mind had become cluttered with endless hair-splitting and with a slavish clinging to the letter rather than to the spirit of Aristotle's texts, so that Aristotelianism, for the time at least, had outlived its usefulness.

It is little short of astonishing how the champions of Descartes, illustrious and legion for more than a century, have been forgotten. One suspects that few of the following names will be familiar. There were physicians like Regius (Henry de Roy or Le Roy), at Utrecht, who after 1639 became Descartes' foremost representative in Holland, the first country to receive hospitably the new philosophy; Louis De La Forge, professor at the university of the French Protestants at Saumer, though himself a Catholic; and the Neopolitan Giovanni Alfonso Borelli (1608–1679), the most gifted of the Cartesian physicians and physiologists in Italy. There were also many physicists. The names of a dozen could be gleaned from a history of Cartesianism. Least unfamiliar will be Jacques Rohault (1620–1675), translations of whose work were used at Cambridge until the books of Newton made them obsolete; and Cardinal Gerdil (1718–1802) whose treatise was one of the last and ablest of the defenses of the Cartesian physics.

Descartes was not neglected even by the poets. Expositions of the new system were written in verse by Abbé Genest (1639–1709) and by Benedetto Stay (1714–1801), Latin poet, born at Ragusa, who become secretary to three Popes. But the master influenced literature in a subtler way. His *Discourse on Method* was the first philosophical work to reveal the clarity and precision of the French vernacular. French literature of the classical period, under the spell of Descartes, became concerned with exhibiting the excellence of reason in human conduct, in contrast with the emotions.

The prestige of Cartesianism affected the law. There was Henri François Daguesseau (1668–1751), Chancellor of France, who was so zealous a French patriot that he refused to license the publications of the Newtonians. In the eighteenth century, indeed, it grew to be a matter of patriotic duty as well as philosophic truth that loyal Frenchmen should champion Cartesian rationalism at the expense of British empiricism. One suspects that patriotic fervor sometimes was the stronger motive. An achievement of Voltaire, showing his extraordinary open-mindedness, was that he dared defend Newton in France.

Indeed, the Cartesians, although at first they suffered persecution at the hands of the conservative Aristotelians, whether Catholic or Protestant, ended by becoming powerful in science, philosophy, literature, law, theology, and education. Seldom in modern times, unless one considers the wide cultural influence of Darwinian evolution, Marxism, and the Freudian psychology, has an intellectual movement pervaded so many departments of life. The wonder is that its power fell as rapidly as it did before the attacks of the empiricists.

With these preliminary remarks we are ready to look at the Cartesian method. In order to understand the Cartesian method it is important to remember that Descartes was above all a mathematician. Applying algebraic means to geometrical analysis he systematized what we now call Analytic Geometry. It was really the method he used in these studies that he tried to generalize into a method for all scientific inquiry.

Since the Cartesian procedure grew out of mathematical study, the scientists who favored him were armchair thinkers rather than mechanics. They needed no other equipment than a quill, a ream of paper, and some ink to unravel from their minds any amount of closely knit reasoning.

The four rules of method which the master gave in his *Discourse* at first glance seem

trivial. The basic one concerns the criterion for selection of the ideas which we should hold:

> Not to accept anything for true which I did not clearly know to be such; that is to say, carefully to avoid precipitancy and prejudice, and to comprise nothing more in my judgment than what was presented to my mind so clearly and distinctly as to exclude all ground for doubt.

We should accept only ideas that are obviously true. This rule in a laboratory would be inane. The laboratory assistant is not concerned with what he knows, but with the precision of his instruments and the accuracy of his recordings. The advice does, however, pierce to the point for the sheer thinker who is marshalling axioms and definitions to prove a geometrical theorem.

The remaining rules also are the report of technique by a case-hardened mathematician. His advice concerns analysis of a theorem to be proved into its parts, order of steps in proof, and exhaustiveness:

> To divide each of the difficulties under examination into as many parts as possible and as might be necessary for its adequate solution. . . . To conduct my thoughts in such order that, by commencing with objects the simplest and easiest to know, I might ascend by little and little, and, as it were, step by step, to the knowledge of the more complex; assigning in thought a certain order even to those objects which in their own nature do not stand in a relation of antecedence and sequence. . . . In every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted.

A mathematical student will be aware that these rules involve an important factor not explicitly mentioned. This is the use of intuition ("clear and distinct ideas"). In the end one depends upon intuition for the discovery and choice of axioms, for the shrewd breaking-up of the problem into parts, and for the efficient and solution-conducive order in steps of proof. There are no rules for guiding intuition. Practice helps, but if one does not have happy intuitions one will be inept even at mathematics of high-school grade.

Intuition is the key word of the Cartesian method. If Descartes and his followers had confined their "clear and distinct ideas" to mathematics, the struggle between the right and left wings of the scientific party would never have occurred. But Descartes had other intuitions. Sitting in his armchair he became aware of the essence of matter: Matter = extension. This proposition appeared to him with all the certainty of the proposition that the straight line is the shortest distance between two points. He toyed with his intuition of matter, passing on to other "clear and distinct ideas." A vacuum is an impossibility. If matter = extension, an extension which is not matter is absurd in the same utter way as a plane area bounded by three sides which is not a triangle. An atom (in the classical sense of least reducible particle) is an impossibility, because extension is precisely that sort of thing which can be halved indefinitely.

Conceiving of motion as a push applied to matter at the Creation, Descartes developed his Theory of Vortices or whirlpools in matter. By this conception, analogous perhaps to some forms of the modern electron theory, he tried to explain all physical phenomena: the motions and genesis of the heavenly bodies, the nature and transmission of light, weight, physiological and biological processes, and the existence of apparently discrete bodies like stones, blades of grass, the sun, comets, and planets. The Theory of Vortices, in short, played the same role in his natural philosophy as the atomic theory has in others.

An additional intuition about motion was that, since the primal "push," it has been constant. Transfers take place, but no motion has ever gone out of existence and none ever has or will come in. This is the Principle of the Conservation of Movement.

In this process of moving from one clear and distinct idea to another, Descartes devised his own laws of motion which stand in curious contrast to those of Newton. The Frenchman's primary laws of motion were: I, each thing perseveres in its state until a new cause supervenes which destroys it; II, no particle of matter ever tends to continue its motion in a curved line, but instead in a straight line; III, a body in motion which encounters another loses its determination, but not its movement. His seven secondary laws concern communication of motion, and are in error. Descartes made it impossible, finally, for his followers to adopt the popular conception of Newton's gravitation, according to which it is an occult force traversing

empty space. In the Cartesian world motion is transmitted only by contiguous bodies, so that force playing upon objects at a distance is unthinkable.

The first reaction one has to this array of speculation is a lively impression of its author's genius. Descartes was the creator of a technique in thinking by which he was able to give the world a new branch of mathematics, a new physics, a new cosmology, and a new physiology. But how successful was the Cartesian method? How much of this new science is true? Here praise must be qualified. The mathematical contribution was sound and was a preliminary to the invention of the Calculus by Newton and Leibniz. The general intuitions, moreover, were fruitful: that matter is of one kind throughout the universe; that there are laws of nature according to which all motions take place; and that all physical happenings, including physiological and biological processes, are explainable in terms of matter in motion. These constituted a platform shared by Galileo and his partisans as well as by the Cartesians, and for three centuries the insights have proved of indispensable worth to scientific enterprise. But when we come to evaluate the specific contributions of the Cartesians to science, we must admit that aside from Analytic Geometry, the Principle of the Conservation of Movement, and the insight that air has weight, there were perhaps none—nothing to compare with the host of laws discovered by Galileo, Boyle, Kepler, and Newton, and no specific invention to revolutionize industry like the steam engine of Watt.

Why did the Cartesian method fail? It worked in mathematics. Why should it not also have worked in the other sciences? We still have enough of the Cartesian left in us to imagine proudly that the universe is arranged according to our mathematical ideas, and that if we could grasp the true axioms and other basic concepts, we could unravel the laws of nature without having recourse to experiment and observation. Galileo himself had some of this bravado; he liked to boast occasionally that he used experiment to prove to those less wise than he what he already knew. But the unfortunate fact remains that we are never quite certain whether our mathematical reasoning holds true of nature; whether our axioms are true; or whether our definitions are not conventions of language rather than statements about things. Indeed, we are not even certain that the universe is wholly rational, that is, open in its uttermost depths to the pure reasoning powers of us puny mortals. This uncertainty infecting our minds when we reason about things not created by our reasoning is one of the causes for the failure of the Cartesian method.

The question of the inadequacy of the high a priori road in science is too difficult to be disposed of here. History will bear us out if we restrict ourselves to the modest assertion that the technique of pure mathematics is not enough when the thinker seeks to decode the laws of physics, chemistry, physiology, or of any other science treating of things in the physical world and presumably independent of our personal reasoning habits. The thinker must quit his armchair and go into the laboratory where there are vernier scales, clocks, lenses, and other instruments to refine and augment the powers of the senses. There he must ignore, as much as possible, what his reason tells him ought to be, and allow his judgment to be molded by facts largely alien and uncontrollable. Like Galileo he must study things in the same way as does the carpenter or plumber. His workshop has little in common with the snowbound hut where Descartes had his vision of the basis of true science.

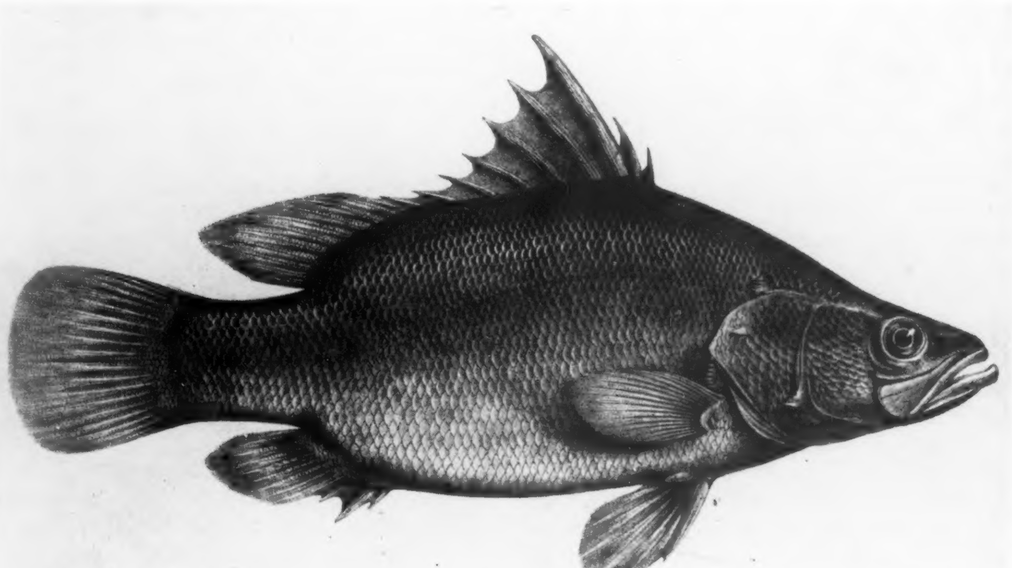
THE GIANT FRESHWATER PERCH OF AFRICA

By E. W. GUDGER

AFRICA, that dark continent of great lakes and mighty rivers, lying under the tropic sun, has many ichthyological rarities. Like its neighbor across the Atlantic, it is a continent of catfishes. Boulenger, the great authority on African fishes, states that there are about two hundred species of Siluroid fishes in its waters. So far as I know, no one has estimated the number of species of these fishes in South American rivers. But as I have shown elsewhere, there are surely three and possibly thirteen kinds of giant catfishes in these rivers. On the other hand, Africa, with physical conditions very much the same, might be expected to produce a whole flock of great Siluroids; but for some unknown reason, it has not produced even one catfish worthy of mention because of its size.

Indeed, Africa's only giant freshwater fish is a percoid, *Lates niloticus*, the Nile perch. However, it is literally a giant perch, reaching a length of six feet. Its distribution is a curious one. Although found throughout the Nile from Lake Albert to its mouths, the Nile perch is not peculiar to the Nile, but is found also in the large western-flowing rivers —the Senegal, Niger, and Congo. For some unknown reason, it is absent from the Zambesi and other South African rivers. As we shall see, it has long been known in the Egyptian Nile and its portrait was painted in remote antiquity.

The Nile perch is not only the largest freshwater fish in Africa, but also the largest freshwater percoid in the world. Large specimens run ordinarily to 4 or 4½ feet in length. At the Sports Club in London there was recently a preserved (mounted?) specimen of a Lates whose weight was given as 253 pounds. It was said to have been caught in Lake No, at the junction of the Bahr el Ghazal with the Bahr el Jebel or Nile proper. Another from Lake No is said to have weighed 280 pounds. Lortet and Gail-



After Boulenger, 1907

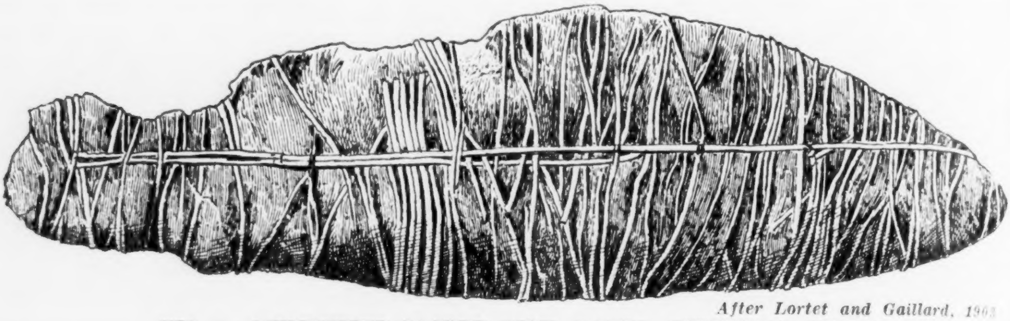
FIG. 1. THE NILE PERCH (*LATES NILOTICUS*)
THE LARGEST FRESHWATER FISH OF AFRICA AND LARGEST FRESHWATER PERCOID IN THE ENTIRE WORLD.

lard (*Archives Museum d' Histoire Naturelle de Lyon*, 1903, Vol. 8, pp. 185–190) measured one 71 inches long, and state that they had seen caught at Assuan several individuals over two meters long—probably more than 80 inches overall; but they do not say that they actually measured these specimens. At the time of the publication of his book, *The Fishes of the Nile* (1907), Boulenger gives as the attested record Lates known to him, one taken a few miles up the Sobat River, the most southern Nile tributary from Abyssinia, in about 9° N. Lat. This great perch was 73 inches in length, 55 inches in girth, and weighed 266¾ pounds.

Little is known about the natural history of this splendid fish, which is beautifully portrayed in Boulenger's drawing (Fig. 1). Efforts made at Cairo to keep large specimens in the Aquarium were not successful; they fed ordinarily on live fish but lived only a few days or at most a few weeks. However, some young specimens thrived and grew rapidly, often at the expense of their smaller and weaker brethren who mysteriously disappeared—evidently down the gullets of their stronger cannibalistic fellows. The word Lates is derived from the Greek word *latos*, the name for a perch-like fish of the Nile, and is now restricted to this particular form.

The ancient Egyptians were animal worshippers and it is interesting to note that they did not overlook the superb fish which we know as *Lates niloticus*. It was much venerated by them and its mummified remains, scattered throughout the valley of the Nile, are very numerous. There was a special cult of Lates at Esneh on the Nile in Upper Egypt (Lat. 25.4° N.), where it was worshipped as a divinity of the first rank, and for this reason, in Graeco-Roman times the town was called Latopolis—the city of the Lates fish.

At Esneh, Lates mummies have been found in great numbers buried at shallow depths in a sandy plain near the town. Examination of these mummies showed that the large specimens had each had an abdominal incision made to permit easy entrance of the mummifying solution. Then each fish had evidently been subjected to prolonged immersion in a strong brine from one of the Egyptian natron lakes, but there was no evidence of the use of asphalt or bitumen. (This was ascertained by making a chemical analysis of the flesh of the fish and of the wrappings.) Next the fish was swathed in linen cloths, and these were secured by many circumferential windings of cord. These in turn were held in place by a longitudinal cord (Fig. 2). The curing in pickle may have been done after the fish had been wrapped. Finally, the mummified fish were buried in the dry sand.

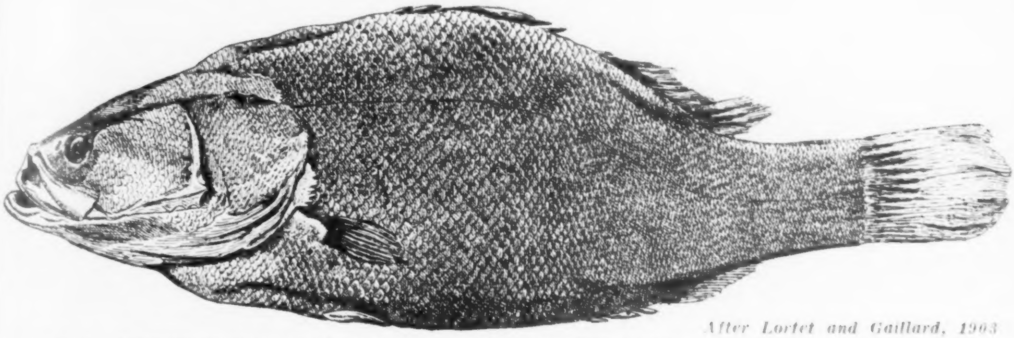


After Lortet and Gaillard, 1903

FIG. 2. MUMMIFIED SACRED FISH, LATES, EXTERNAL VIEW

FROM ESNEH, UPPER EGYPT. SHOWING LINEN SWATHINGS AND LASHING CORDS THAT FORM THE MUMMY CASE.

Thus prepared and buried, these mummies in the dry air and dry sand of Upper Egypt have "kept" perfectly and when exhumed after twenty-five centuries are found, according to Lortet and Gaillard, to possess almost as much animal matter as dried codfish in our markets. Figure 3 shows what was found when the wrappings (seen in Fig. 2) were removed, and when the dried salty slime in which the fish had been pickled had been wiped off with a damp cloth. This fish has been marvelously preserved. Note not only the splendid form of the body, but the wonderfully preserved scales and lateral line, the



After Lortet and Gaillard, 1903

FIG. 3. MUMMIFIED LATES UNWRAPPED AND CLEANED OF DRIED SALTY SLIME
THIS FISH HAS BEEN PERFECTLY PRESERVED, EVEN WITH SCALES, FINS, AND EYEBALL, FOR 25 CENTURIES.

fin-rays, and membranes. Most notable of all is the fact that even the very eyeball is intact. Many such finely preserved specimens were about five feet long.

There is a large animal cemetery at Gurob on the border of the district of the Fayum on the west bank of the Nile about sixty miles south of Cairo. Fifty burial pits here were exhumed by L. Loat and reported on in 1904 (*Egyptian Research Accounts*, X, p. 3). From these pits, Loat obtained remains of scores of Lates. Unlike the Lates at Esneh, these were not mummified, but were sometimes wrapped in bundles of grass, or covered with ashes obtained by burning the grass. Various animals were buried here but the Lates' remains predominate. Over and over Loat notes "no preservative." The fish were wrapped in grass, partially covered with ashes, or laid down as caught. Not

From Flinders Petrie, pl. XII, 1892

FIG. 4. A NILE PERCH CARRIED ON THE HANDLE OF A BOAT PADDLE
FROM A PAINTING ON THE SOUTH WALL OF THE TOMB OF THE PRIEST, RAHOTEP, AT MEDUM IN LOWER EGYPT.

being mummified, the flesh has gone, leaving only the loose bones, or sometimes rather complete skeletons, as Loat's photographs show. In the photographs, sometimes the outline of the fish's body shows quite plainly. Study of these remains of large fish showed that the abdomen of one had been opened (the vital organs probably removed) and the cavity filled with ashes, while the mouth and gill openings of another large specimen had been filled with ashes. This looks as if some attempt had been made to use ashes as a help in preservation, but Loat repeatedly notes "no preservatives"—such as was used on the Esneh fish. Desiccation and slow oxidation have left nothing but the hard parts. The rough outline of the body in some cases (as shown in Loat's photographs) is probably due to the scales on the under side of the body remaining somewhat intact. Thus one fish, it is said, measured "5 feet 6 inches long, and nearly 2 feet in depth."

These remains of Lates ranged from small to large. Loat repeatedly speaks of large specimens, and for the better preserved fish gives measurements: 5 feet; 5 feet and 2 inches; 5 feet 6 inches (2 specimens, one "nearly 2 ft. deep"); and last of all, "one large fish, nearly 6 ft. long." From this one must not conclude that Lates grew larger in olden days, but that the fishery then was probably less efficient than today and the fish had a better chance to attain full growth.

It is interesting to note that in contrast to burial pits for oxen and goats at Gurob, the pits for fishes were more carefully dug, and in many cases only a single fish was found in each pit. If two or more fish were buried together, a certain order was observed; either they were laid side by side, or head to tail, or placed in layers, and in no case was any other fish or animal species found with Lates. These things indicate the great reverence in which the fish was held.

Paintings of Lates are found on the walls of various tombs in Egypt, particularly on those of Medum, which is on the left bank of the Nile between the river and the Fayum, about fifteen miles north of Gurob. On the south wall of the mastaba (or tomb) of

Figs. ×2 from Russenger's Reisen, 1846

FIG. 5. GREEK COINS OF LATOPOLIS

ANCIENT COINS SAID TO PORTRAY THE NILE PERCH.

Rahotep, high priest of Heliopolis (the city of the Sun), is an easily recognizable representation of the Nile Perch (Fig. 4). Here a large specimen of Lates (apparently about 5 feet long) is carried on the long handle of a paddle supported on the shoulders of two men. This figure closely resembles the one drawn for Boulenger. Even seven of the nine dorsal spines are shown, the eighth and ninth being so incorporated in the soft dorsal fin as to be easily passed over. According to an Egyptologist, the Medum Lates was painted about 2780 B.C.; thus it is probably the oldest figure of a fish of historic times.

But the Egyptians were not content with portraying the fish in a painting. Boulenger writes that in 1899 he was shown ". . . a bronze model, 115 millimeters long, which at once suggested to me a young *Lates niloticus*. This model contained a mummy of a small fish, the loose bones of which I have been able to examine and to identify as those of a young Lates."

Boulenger states that, on certain ancient Greek coins of Latopolis, there are representations of a fish which he and Russeger recognize as Lates (Fig. 5). It is noted by Russeger, from whom the figures of the coins are copied, that on the reverse side of each coin is found an effigy of Hadrian, the Roman emperor whose reign covered the years A.D. 117–138. This establishes the fact that these coins were minted more than 1800 years ago. However, a mere glance shows that the artist, who cut the figure of the fish on the dies from which the coins were struck, was not in the same class with the painter who depicted Lates on the wall of the tomb of Rahotep at Medum, thousands of years earlier.

USING HYDROGEN TO SAVE COAL

By PHILIP L. ALGER

When one passes a high voltage substation where electric power lines meet in a forest of steel towers and insulators, one may see a large steel cylinder with rounded heads. Such a cylinder is probably the housing of a hydrogen-cooled synchronous condenser—a high speed generator of reactive electric power, rotating in a sealed tank of ninety-seven percent pure hydrogen (Fig. 1).

The first of these machines went into service in Pawtucket, Rhode Island, in 1928, but for seven years before that time they had been under development, and during the fifteen years that have followed, their use has continued to increase. Now they have become an important factor in meeting the war demands for electric power that have threatened to exceed the country's capacity to meet.

It would be difficult to find a better example than the hydrogen-cooled generator of the birth of an idea in the atmosphere of pure science and its systematic and persistent development by cooperative effort into a reality of great practical importance. In 1921, Dr. Willis R. Whitney, Director of the Research Laboratory of the General Electric Company, wrote a note (Fig. 2) to one of his young research assistants, Chester W. Rice. That note started a long train of events, the consequences of which are not yet fully developed. Two results are that more electric energy than was thought possible is being produced from given amounts of copper, steel, and other critical materials in the generating equipment on the one hand, and from given amounts of coal or oil fuel on the other hand. It has resulted in the saving of not less than one hundred and fifty thousand tons of coal during 1943 in the production of electric power in the United States. Since this saving will continue and greatly increase, it will postpone the time when our coal mines will be exhausted.

Dr. Whitney's question arose because as larger and higher speed generators were made, the heat dissipation and power loss associated with churning up such a heavy ventilating medium as air were becoming serious. But the idea of using a lighter gas did not solve anything—it merely opened up a whole series of other questions, such as:

What properties of a gas would be best for cooling electric generators?

What gas provides the best compromise between windage losses and cooling?

What will be the effects of this gas on electrical insulation?

Is a gas-tight enclosure, including shaft sealing, practicable for turbine driven generators?

How about explosion risks if hydrogen is used?

What about filling and emptying procedures, operating controls, and the auxiliary equipment required?

Will the benefits justify the increased production costs, not to mention the cost of development?

Before a practicable result could be anticipated, it was evidently necessary to answer these questions, and a lot more that would certainly be uncovered later. Chester Rice started, therefore, by making an intensive investigation of the free and forced convection cooling properties of gases. Early in this study he found that gas viscosity is a factor of the first importance in heat transfer properties, and he was thus led to build on Langmuir's stagnant film theory, which reduced the hopelessly complex convection problem to one of heat conduction in the steady state. Langmuir's earlier application of the laws of conduction, radiation, and convection, derived from his film theory, enabled him to more than double the efficiency of the incandescent lamp. Rice extended these laws by the method of dimensions to cover the analysis of the cooling of rotating machines, and he conducted a great number of experiments on numerous liquids and gases to determine practicable working formulas. He found that hydrogen, with seven percent of the density of air, has seven times as much heat conductivity, fourteen and five-tenths times as great specific heat, and a

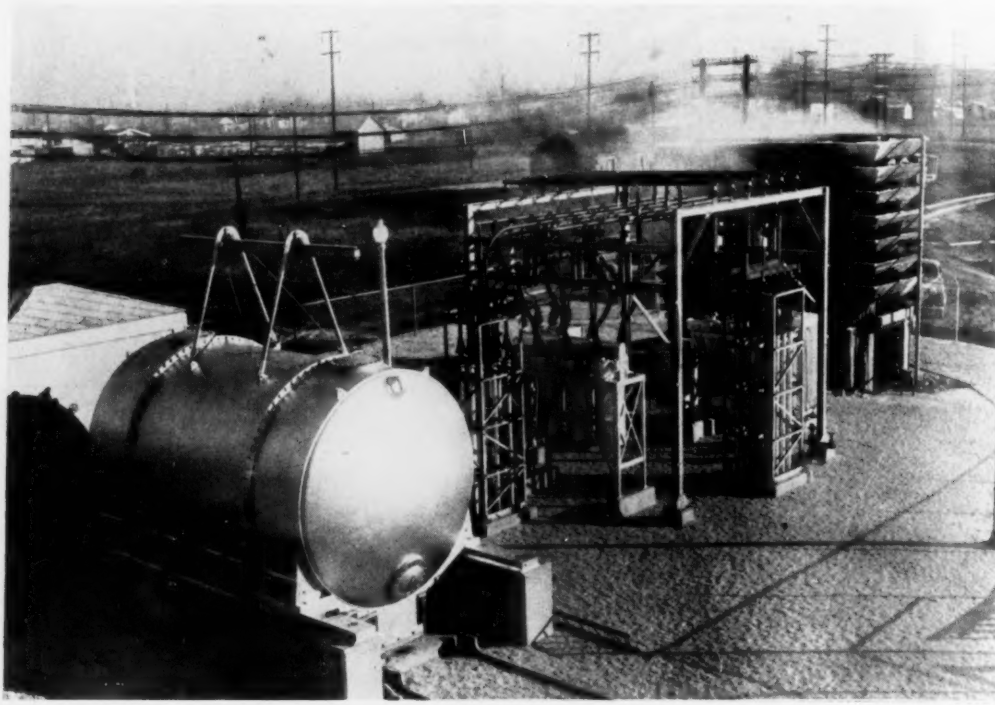


FIG. 1. OUTDOOR SUBSTATION
WITH HYDROGEN-COOLED SYNCHRONOUS CONDENSER, 30,000 KVA, 11,500 VOLTS, 60 CYCLES, TYPE TSC-GL.

thirty percent greater coefficient of surface heat convection, making it clearly superior to all other gases for minimizing both the cooling and windage losses.

His results were presented before the American Institute of Electrical Engineers and published in a fifty-page paper in the *Transactions* for 1923. The interest of engineers being thus aroused, a 6,250 kilovolt-ampere turbine generator was built, and was run in hydrogen for extended periods. This work showed that hydrogen gave the anticipated results so far as cooling and windage losses were concerned, proving that roughly twenty to twenty-five percent greater electrical output could safely be obtained from a machine of given dimensions if operated in hydrogen instead of air. This opened up a new train of development, as it suggested that steam turbine driven generators of 25,000 kilowatts and larger could be built to run at 3,600 instead of 1,800 revolutions per minute. Such an increase in speed would make possible large increases in steam turbine efficiency.

Numerous measurements were made of temperature rise and windage losses under different conditions; and twenty-five explosions were set off in the generator with different mixtures of air and hydrogen. On the basis of heat content, ignition of the most explosive mixture of air and hydrogen (about five parts of air and two of hydrogen) should develop a pressure of about one hundred and eighty pounds per square inch. The tests showed, in fact, that explosion risks could be discounted because the maximum pressure recorded over the full range of mixtures was forty-five pounds per square inch. However, later tests on a 12,500 kilovolt-ampere synchronous condenser frame, before the rotor windings or coolers were installed, developed a maximum instantaneous pressure of eighty-five pounds per square inch. Frames are readily designed to withstand even these pressures.

Meanwhile, tests of eight thousand hours' duration were being conducted on electrical insulation exposed to high voltages in air and hydrogen. These demonstrated that corona, due to dielectric stresses exceeding the ionization potential of the gas, causes

very little damage to organic materials in hydrogen, whereas in air rapid deterioration occurs. Furthermore, in the absence of oxygen, the damage due to an electrical failure is normally confined to only a few coils, whereas with open type air-cooled machines a fire may spread with great rapidity and damage the entire winding beyond repair. These conclusions gave hope for materially greater insulation life and reduced maintenance in hydrogen-cooled machines.

All these results were reported to the American Institute of Electrical Engineers in 1925, arousing much discussion and stimulating others to conduct similar investigations. Thus at an early stage in the development of the invention not only the original inventor but others were actively at work on both theory and experiments. This open publication and the discussions of both theory and experiment long before any financial returns had been received were possible only because the inventor was protected by a patent under the American patent system. In 1923, also, a United States patent was issued to Max Schuler on the basis of claims filed in 1916; this patent was purchased by the General Electric Company.

While the engineers were experimenting with a full-sized generator, Rice made an ingenious revolving disc apparatus in a bell jar for measuring windage losses in different gases. With this apparatus he carried out experiments with air, hydrogen, and carbon dioxide at different atmospheric pressures. These experiments verified the proportionality of windage losses to gas density and gave valuable information on the design of ventilating fans for hydrogen circulation. Rice reported these experiments in the May, 1925, issue of the *General Electric Review*.

The question of how to prevent hydrogen leakage through the bearing clearances on a large turbine generator shaft now appeared as the limiting feature of design. To provide for an adequate thickness of oil film in the bearing for both load carrying and cooling purposes, it is necessary to have a radial clearance of the order of one thousandth of an inch per inch of diameter without which a prohibitive leakage would occur in the absence of a seal. Research work during the next two years was concentrated on this problem, when the inventor developed a satisfactory liquid film seal. Vacuum-treated oil was pumped into an annular groove in a babbitted sealing ring dividing it into two streams flowing in opposite directions along the shaft, and draining it into two independent detraining tanks. The hydrogen absorbed by the oil on one side, and the air absorbed on the other side, are partially given up in these tanks, and the oil is then vacuum-treated to remove the remaining air and hydrogen, cooled and pumped to the seals. Many variations from this seal have since been developed, but in general the basic liquid film features have been retained. This work was also published by Rice in the *General Electric Review* (Nov. 1927).

Further consideration of shaft sealing auxiliary equipment, coupled with some practical doubts concerning explosion risks in large power stations, deflected the engineers during the next few years to the study of synchronous condensers. Since these machines are operated as idling synchronous motors, neither driving nor being driven, they do not require any shaft seals. Further, they are usually located at outlying substations where any explosion damage would be inconsequential. Consequently, effort was devoted to frame structures, hydrogen-tight welds and gaskets, and new designs to take advantage of the better cooling afforded by hydrogen. It was then found that the hermetically sealed frame designs were ideally adapted to outdoor operation, with consequent saving in building expense and reduced explosion risks. At last two hydrogen cooled condensers, of 12,500 and 20,000 kilovolt-amperes rating, were ordered in 1927 and were put into operation in June and December, 1928.

This advance was reported to the American Institute of Electrical Engineers by R. W. Wieseman in 1929. In the next few years, large numbers of these machines were installed, the total kilovolt-ampere capacity in service reaching 161,000 on the American Gas and Electric Company system alone by 1939, and the total of all those shipped by General Electric reaching 593,000 kilovolt-amperes in 1943. Reduced windage losses in these machines are believed to save annually the equivalent of 25,000 tons of coal.

Received about
Feb 21, 1921
CWR

Dear Chester

Could I create an interest for you in a series of fool stunts which have, I think, the promise in them of some useful outcome.

I'd like to study experimentally (not on paper) because I expect the unexpected when we deal with such a complex subject. and this is it.

I want to take a motor-generator set and enclose it gas tight. replace the air with Hydrogen and run the thing. When this is done I want to see what the effect was (not before) I want to know whether it ran (1) easier (friction against gas skin friction) (2) cooler because of thermal conductivity of the Hydrogen (3) safer for the insulation because it might stand higher temperature in H_2 than in O_2 without decomposition safer because it might arc less and electrically break down less easily because in H_2 arcing distances are greater (4) Perhaps the speed attainable economically would go up with the H_2 and speed, in such things as turbine alternators & Alex^n machines is important. This might all lead to substitution of H_2 by CO_2 or vacuum, but it could hardly be carried thru a series of practical tests without adding a lot to our knowledge and might find a real useful application. Don't worry about cost of the leakage nor danger. I've got that done enough already.

Whitney

FIG. 2. ORIGINAL LETTER FROM DR. WILLIS R. WHITNEY TO CHESTER W. RICE
IN THIS WHITNEY SETS FORTH THE PROPOSED INVESTIGATION OF HYDROGEN-COOLED ELECTRIC GENERATORS.

A 24,000 volt synchronous condenser has been operating in hydrogen since 1931 without any insulation difficulty. Since both oil and insulation remain fresh and clean in the hydrogen atmosphere, routine inspections of these machines are usually made at only five-year intervals, the hydrogen seals being unbroken meanwhile.

The success of hydrogen cooling for condensers led to renewed studies of generator designs and shaft seals, but the onset of the economic depression delayed actual construction until 1936. The first commercially operated hydrogen-cooled turbine generator, of 25,000 kilowatt rating and 3,600 revolutions per minute, went into service at Millers Ford Station in Dayton, Ohio, in October, 1937, as reported in the May 7, 1938, issue of the *Electrical World*. A general report on the operation of four of the earliest hydrogen-cooled generators was made by E. H. Freiburghouse and D. S. Snell in August, 1938, after the latter had spent several very arduous weeks in putting the pioneer installation into shape for operation. The curve in Figure 3 shows the rapid increase in shipments of these generators since that time, reaching a cumulative total for the General Electric Company alone of 3,878,000 kilovolt-amperes by the end of 1942.

By inspection of Figures 4 and 5, some realization of the technical problems involved in this development can be gained. The body of the 60,000 kilowatt generator rotor in Figure 4 is a one-piece alloy steel forging some thirty-six inches in diameter and thirty tons in weight that has been put through a carefully controlled heat treating cycle of several hundred hours duration. It is slotted to receive a two-pole field winding of strap copper or aluminum, whose ends are held in place by high-strength alloy steel retaining rings. The peripheral velocity of the rotor surface is of the order of six miles per minute, and the kinetic energy of the entire mass, when revolving at normal speed of 3,600 revolutions per minute, is some sixty-five thousand foot tons, or fifty kilowatt hours. The pressure developed by the rotor fans is roughly equivalent to twenty inches of water for air or two inches for hydrogen, and the windage and fan losses are about 900 kilowatts for air and 90 for hydrogen. To reduce these losses, it is usual to use external fans for the large air-cooled machines. The total losses exclusive of windage are about 550 kilowatts, so that the use of hydrogen raises the generator efficiency from 97.5 to 98.7 percent. Figure 6 shows the outline dimensions of two 50,000 kilovolt-ampere generators, one designed for air and the other for hydrogen cooling.

TABLE 1

CUMULATIVE SAVING OF COAL FOR GENERAL ELECTRIC GENERATORS

Year	Cumulative total equipment shipped	Cumulative saving of coal
	KVA	*Tons*
1937	258,000	0
1938	730,000	8,000
1939	1,067,000	30,000
1940	2,061,000	62,000
1941	2,737,000	124,000
1942	3,878,000	206,000
1943		322,000

In designing large generators making 3.600 revolutions per minute, it has been found desirable in many cases to use aluminum field windings, the light weight of the aluminum more than making up for its poorer electrical conductivity. In this way, larger rotor diameters are permissible with-

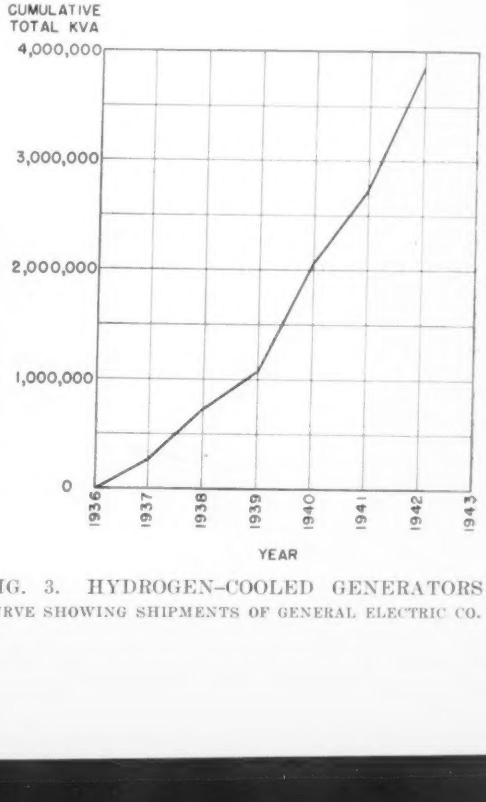


FIG. 3. HYDROGEN–COOLED GENERATORS
CURVE SHOWING SHIPMENTS OF GENERAL ELECTRIC CO.

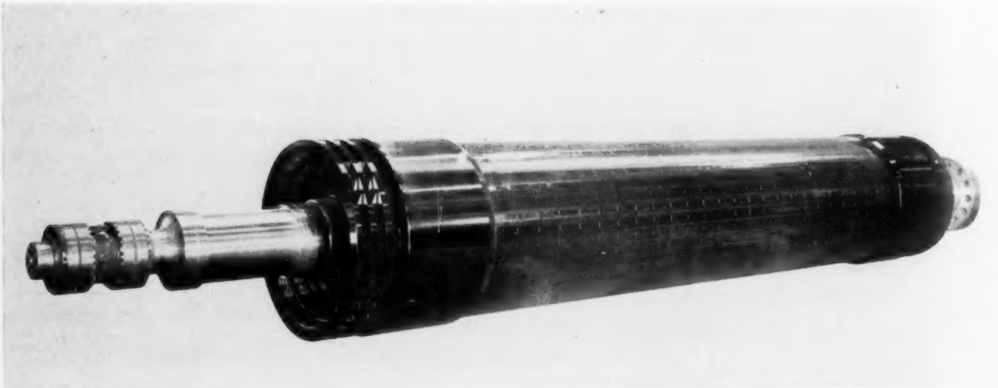


FIG. 4. WOUND REVOLVING FIELD FOR SYNCHRONOUS A-C TURBINE GENERATOR
81,250 KVA, 3600 RPM, 13,800 VOLTS, 60 CYCLES, TYPE ATB-HT, 2 POLE. OBLIQUE VIEW FROM FRONT END.

out exceeding the allowable centrifugal stresses. Hydrogen cooling is singularly well adapted for use with these larger rotors, since it obviates the serious disadvantage of very high windage losses, which would occur in air. Table 1 shows the cumulative saving of coal for General Electric generators alone.

These savings have been conservatively estimated on the basis of an improvement in generator efficiency equal to one percent of the kilowatt rating at all times that the unit is in operation. The saving is, of course, two percent of the output during half-load operation, or four percent at one-quarter load, since it is due to reduced rotation losses. It has been assumed that each kilowatt hour saving will save one pound of coal, and it has been assumed also that these new efficient hydrogen-cooled machines would operate 7,500 hours per year, or eighty-five percent of the time.

Considering machines of other manufacture and the synchronous condensers also in service, the saving in coal this year will exceed one hundred and fifty thousand tons, and higher values are indicated for all succeeding years.

The ramifications of this hydrogen cooling development are very numerous, and many of them are of great scientific interest. For example, in the oil sealing of the rotating shaft questions had to be settled regarding the rate of absorption of pure hydrogen and air by oil at different viscosities and temperatures, and the rate of detraining of

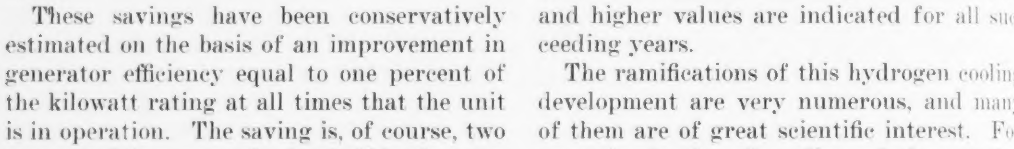


FIG. 5. HYDROGEN-COOLED A-C TURBINE GENERATOR
66,667 KVA, 3600 RPM, 11,000 VOLTS, 60 CYCLES, TYPE ATB-HT. VIEW OF LONGITUDINAL SEMISECTION.

these gases from the oil under various vacuum conditions. Also, extensive investigations were required of the properties of gas mixtures, ranging from pure helium, pure hydrogen, methane, and carbon dioxide through various mixtures of these gases with one another and with air. Pure helium, which has frequently been suggested as a substitute for hydrogen, would have a gas temperature rise thirty-five percent greater than that of the air-cooled machines, for the same rate of gas circulation and the same losses, the product of specific heat and density for helium being seventy-four percent of the value for air. While the reduced density of helium would reduce the windage losses to only fourteen percent of those in air, the disadvantage above mentioned and the higher cost have prevented its use in any machines built to date. Many problems also had to be solved in connection with the circulation of hydrogen through the ventilating passages of high speed machines, and the development of fans and hydrogen-to-water coolers.

When the first hydrogen-cooled machines were built, a major difficulty was hydrogen leakage through the welds. The Turner 20,000 kilovolt-ampere condenser built in 1928 lost initially 18,480 cubic feet of gas weekly, but the Scarboro 15,000 kilovolt-ampere machine of 1930 lost only 1,000; and in 1936, when the Fostoria 1,200 revolutions per minute, 30,000 kilovolt-ampere condenser was installed, its leakage was only twelve cubic feet per week. This latest machine was designed for operation in hydrogen at twice atmospheric pressure at twenty percent above its normal hydrogen-cooled rating.

The leakage from the largest present-day hydrogen-cooled generators, including seal losses, normally only amounts to a dollar a day, and only one hundred dollars worth of hydrogen is needed in order to place one of them in operation. It thus costs something less than five hundred dollars per year to supply and maintain the hydrogen atmosphere. For this five hundred dollars there is a direct saving of the order of ten thousand dollars worth of coal for a fifty thousand kilowatt generator. Today the lower limit of economic use of hydrogen as a cooling medium for steam turbine driven generators is about twenty thousand kilowatts, but indications are strong that this lower limit will be appreciably reduced in the years to come.

A secondary advantage obtained by this development is the reduction of noise, as is evident when one steps into the latest power stations. The windage noise of large high-speed air-cooled machinery, as regularly built a few years ago, is a steady roar, but when these machines are redesigned for operation with internal coolers and heavy steel wrapper plate construction, as for hydrogen cooling, they are so quiet that it is difficult to tell whether they are running or not.

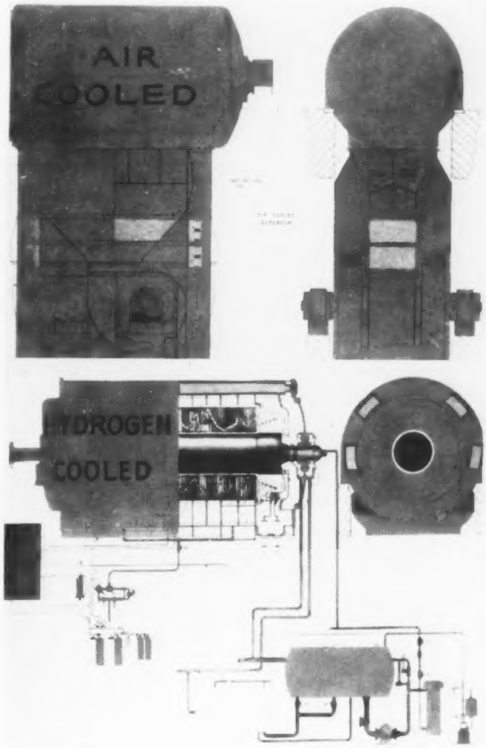


FIG. 6. COMPARATIVE OUTLINES OF AIR-COOLED AND HYDROGEN-COOLED GENERATORS.

Summing up this story, the end result of Dr. Whitney's note is that hydrogen cooling has become standard for nearly all large steam turbine driven generators in the United States. Because of this hydrogen atmosphere, they are more efficient than similar generators operating in air; they are

smaller in size; they are safer to operate; and they will last longer. The advantages demonstrated when the first of such generators was put in service by the Dayton Power and Light Company in October, 1937, were such that only four years later three-fourths of the turbine generators rated twenty thousand kilowatts and larger were being ordered with hydrogen cooling.

Considering the development as an example of the working of the American system of productive enterprise, it is important to note that at each step in the development the results of tests and calculations were reported to the industry and widely published. This brought in critical comments, which were helpful in guiding the further progress of the work, and stimulated work along alternative lines by research men and competitors. In the course of the work, many different organizations and hundreds of individual scientists and engineers participated, as recorded in more than fifty articles in the technical press.

In historical perspective, the story of hydrogen cooling provides a most interesting record of the free play of invention, publication, discussion, competitive rivalry, and commercial leadership that mark the American way of industrial progress.

At each major step in the hydrogen cooling program, it was necessary to expend large sums in advance of any provable return, and considerable risks had to be assumed. By and large, however, these costs have been borne by those to whom the financial return should ultimately come, while the manufacturers and operators who pioneered in making and purchasing the first machines of this radical new type have each assumed the risks that came within their proper spheres. As it has turned out, there has been no machine out of service because of failure directly chargeable to hydrogen cooling, and the once feared operating risks have proved to be negligible. The increased investment cost of hydrogen cooling has in all cases been paid off by fuel savings after a very short period of operation. The savings in coal, one of the most important natural resources, are cumulative and will eventually amount to enormous figures.

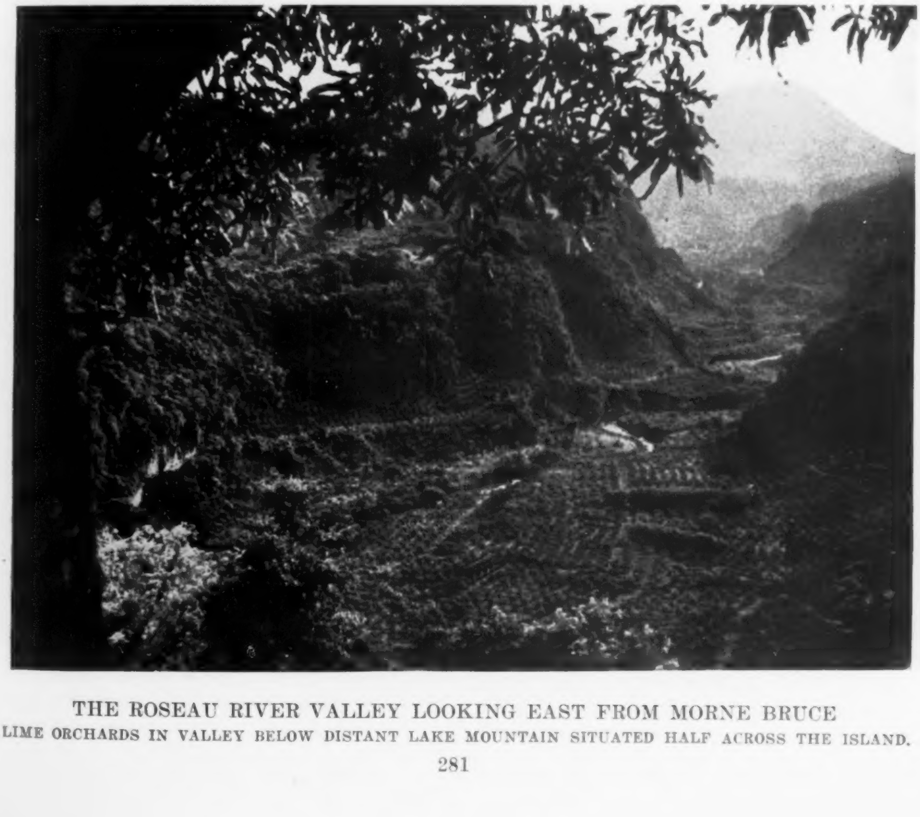
A BOTANIST'S DOMINICA DIARY

II. OFF THE BEATEN PATH

By W. H. HODGE

The Caribbean islands are all geologically young, having arisen from the ocean floor as submarine volcanoes during the early Cenozoic. As a member of a chain of isles which can boast of such ebullient volcanoes as Pelée on Martinique and La Soufrière of St. Lucia, it is not surprising that Dominica still shows signs of active vulcanism. All her peaks are old volcanoes, and a few like Morne au Diable still possess wonderfully symmetrical cones, but present-day activity is limited to the numerous and widely scattered hot sulfur springs. The most striking of these is situated in the region known as the Grande Soufrière, an inaccessible basin hemmed in by mountainous ridges in the southeastern portion of the isle. Like all of Dominica's natural wonders, this Valley of Desolation—a half-day's trip from the little mountain village of Laudat—may be reached only by a rugged forest footpath known to few of the native woodsmen. For many years the exact location of the Grande Soufrière was unknown, and even today it is difficult to find a Dominican who has ever visited it.

The first view of the basin is from the shrubby summit of the peak known as Morne Nicholls, down whose precipitous eastern slopes one must slide and slither in order to get into the small semicircular amphitheater of the valley. Scattered over the valley floor are numerous solfataras bubbling noisily and emitting steamy sulfurous vapors, which continue to arise from the hot streams as they pour out of these vents and rush easterly out of the valley's mouth. The incessant activity of the fumes, wind-blown over the whole extent of the valley, has eliminated much of



THE ROSEAU RIVER VALLEY LOOKING EAST FROM MORNE BRUCE
LIME ORCHARDS IN VALLEY BELOW DISTANT LAKE MOUNTAIN SITUATED HALF ACROSS THE ISLAND.

LOOKING SOUTH OVER THE SUMMIT OF MORNE TROIS PITONS
FIRST PHOTOGRAPH EVER TAKEN ON THIS SUMMIT. MOSSY FOREST CLOAKS ALL THE RIDGES. FAINTER PEAKS IN THE BACKGROUND ARE: GRANDE SOUFRIÈRE HILLS (LEFT); MORNE MICOTRIN BELOW IN FRONT. PROBABLY 400 INCHES OF RAIN FALLS A YEAR IN THE FOREGROUND BASIN.

an otherwise aggressive mountain vegetation, and almost the only plants existing in the vicinity of the fumaroles are tough grasses (*Ischaemum*) and creamy-flowered terrestrial bromeliads (*Pitcairnia*), while submerged in the sinter and travertine deposited by the hot waters grow various colorful algae.

The largest of these springs is the celebrated "Boiling Lake," hardly a lake but an impressive-looking basin, a hundred or more feet across, held in by twenty-five-foot walls. The waters, apparently not deep, are in a continuous seething activity, and blanketing clouds of steam and noxious fumes (which have killed at least one visitor) hover continuously over the surface, making photographs almost impossible. Boiling Lake may represent either the remains of an old volcanic crater or a collection of large fumaroles whose outlet has been dammed by earth slides, thus impounding the hot water. In January 1880 a violent eruption took place in this vicinity; the last volcanic sign was a severe earthquake in 1906.

ROSEAU VALLEY WATERFALLS
BELOW LAUDAT VILLAGE. RUGGED TERRAIN AND HEAVY RAINFALL MAKE WATERFALLS COMMON.

Laudat village makes a good base camp, for besides Boiling Lake, Dominica's only other "lakes" (as well as the peaks of Micotrin and Morne Watt) may also be reached from here. Freshwater and Boeri lakes, east of Laudat, are located in old volcanic craters, barely an eighth of a mile across; yet these very beautiful mountain pools are ranked by provincial islanders among the seven wonders of their tiny world.

It is sometimes hard to realize that Dominica was once a thriving Caribbean center, politically and strategically a threat to the French West Indian aspirations, and yet such was the case. Before the American Revolution broke out, Roseau, Dominica's capital, was a flourishing free port important to traders not only from the other West Indian islands but also from England and North America. Into this roadstead sailed the ships of Drake and Hawkins with cargoes of slaves destined for sale to the French and Spanish planters as well as to those American buyers who came from the colonies.

FRESHWATER LAKE NEAR LAUDAT VILLAGE

THIS SMALL TARN BELOW A MOUNTAIN SUMMIT PROBABLY OCCUPIES AN OLD VOLCANIC CRATER.

STEAM AND MIST ENSHROUD BOILING LAKE

THIS SEMIACTIVE CALDRON OCCUPIES LAND IN THE VALLEY OF DESOLATION, AN INACCESSIBLE BASIN OF ACTIVE VOLCANIC ACTION SITUATED IN THE SOUTHEAST PART OF DOMINICA ISLAND.

CLIFFS ON THE ATLANTIC COAST NEAR CALIBISHIE
THE RUGGED, PICTURESQUE WINDWARD COAST OF DOMINICA HAS A HEAVY SURF AND CONSTANT WIND.

Long a neutral island successively claimed by Caribs, England, France, and Spain, Dominica fell into the hands of the English as early as 1759. But it was too much for the French to have this threat strategically wedged between her important colonies of Martinique and Guadeloupe and, almost before the alliance between the revolting American colonies and France was announced, the French had seized the island by a swift surprise attack from Martinique upon Dominica's southernmost defenses. There, atop a hundred-foot-high narrow peninsula, now known as Scots Head, was located old Fort Cachacrou, which today, like all the old fortresses, is practically obliterated. The few soldiers on duty were cleverly duped into intoxication by ill-disposed French inhabitants; the touch-holes of the cannon were closed with sand so that when, on the morning of September 7, 1778, an attacking party under the Marquis de Bouille stormed the garrison, they were met with the opposition of only a handful of drunken wretches. A few days later a

CARIB CANOES AT SALYBIA
THESE ARE BUILT-UP DUGOUTS, CALLED *kuriala*, USED FOR ALL DEEP SEA FISHING. THEY ARE EQUIPPED WITH CRUDE SQUARE SAILS. NETS ATOP THE OARS ARE USED FOR SNARING FLYING-FISH.

A CARIB FAMILY NEAR SALYBIA IN THE CARIB RESERVE
MISCEGENATION IS RAPIDLY WIPING OUT THE FEW REMAINING NATIVE CARIBS OF THE ISLAND.

French force marched victoriously into Roseau, marking this as the first of a series of successes which were later to bring to the French king nearly all the smaller isles of the Caribbean. Matters were indeed critical, for the English in those days considered these islands far more important in potential wealth than the dissenting North American colonies! Little wonder then that Britain played all her cards in a final slam that saw the armada of De Grasse, newly arrived from victory off Yorktown, defeated by Rodney in one of the greatest naval engagements of all time. Off the north coast of Dominica, near the tiny group of islands called The Saintes, on April 12, 1782, the fleets of these two great naval powers clashed for a victory that decided once and for all which nation was to remain dominant in the West Indies. Since that memorable date French power has dwindled until today Martinique and Guadeloupe alone remain as Caribbean gravestones of what was once a mighty French-American empire. Thus ended one of a series of fights for which the island has long been famous—a warlike heritage handed down from the time of Carib ownership—when Dominica was not so named but was rather known to her savage children by their own and far more descriptive name of Waitubukuli, which means "Scene of Big Battles."

Not to be caught again unprepared, Britain started to construct fortifications on the northwest coast of Dominica to guard the one safe and beautiful roadstead the island can boast—near the tiny village of Portsmouth on spacious Prince Rupert Bay. On the neighboring Cabrits, twin peaks guarding the northern harbor shores, slave labor reared fortifications which boasted of being a second Gibraltar. Today few people even know of their presence. The cannon and great piles of century-rusted cannon balls are still in place, yet all is silent on the Cabrits. Wandering up their forested slopes one would little realize the military grandeur that once existed, so overgrown are the buildings; in fact, one needs a cutlass and a guide in order to find these extensive ruins. Soldiers are still present; they ramble off in their armor in hordes at one's feet—soldier

LOOKING NORTH FROM SYLVANIA HOUSE
LEFT, MORNE DIABLOTIN, HIGHEST PEAK IN THE LESSER ANTILLES; CENTER, MORNE COURONNE; RIGHT, TWIN-PEAKED MORNE GRAND BOIS. ORANGE ORCHARDS APPEAR IN RIGHT FOREGROUND.

crabs, the ghosts perhaps of human hosts of bygone days. And to the shaded parapets, long rent asunder by the roots of forest trees, now ascend only a stray chameleon or gecko. All is silent except for the constant cooing of doves or the sudden whir of wings as a *ramier* (wild pigeon) is startled from the treetops. One even needs to climb a tree to view the placid charm of the sweeping harbor below, sparingly dotted with tiny-oared fishing craft or perhaps a few inter-island sloops, far cries from the days when, it is said, sailing men-o'-war anchored here by the hundreds. Morne Diablotin, the Lesser Antilles' highest peak, slumbering in her perpetual cloud blanket, hovers dreamily over the island's past.

Dominica's longest road, narrow but paved, climbs out of the little village of Portsmouth over the eastern divide to the windward side of the island to Hatton Garden estate, about twenty-five miles distant, and then peters out in the forests lining the valley of the Pegoua River. Climb into a Dominica bus and ride, just for sheer fun, this roller coaster road to Marigot! A great Tarzan of a good-looking Negro will probably be driving, and on the long bare bench that is the driver's seat is usually a fair assortment of the island's good-natured peasantry, mostly laughing women with their gurgling babies. The bus, an old Reo, grunts and groans on the rises and comes to a squealing stop before thatched woodland doll-houses. People get on and off, passing babies from hand to hand to the front or rear of the bus into the arms of the waiting parent who has preceded them. Then comes the rain, only a passing shower but the bus has to stop, for as an air-conditioning aid the windshield was long ago removed. In no time at all the Atlantic appears ahead with her great wind-borne rollers chasing each other upon gorgeous tropical strands while picturesque Calibishie tries to seek refuge beneath her towering coconut palms. How cool and refreshing is this windward coast fanned as it is by a ceaseless breeze, which, combining its strength with that of the water, cuts queer pinnacles, stacks and sea cliffs out of the resisting shore. Even the low coastal vegetation is subdued by the

wind and appears brushed close against the mountainsides.

Villages south of Marigot on this windward coast can only be reached by rough canoe trip or by Carib trail. Following the latter on horseback over red, slippery volcanic soil, we slither atop sea cliffs or plunge into river-hewn gorges which periodically bisect the trail. Amid the wild beauty of this lonely coast there exist, scattered through the wooded slopes near Salybia and Bataka, the lone remnants of the Caribs, that old warlike race which Columbus on his second voyage of discovery found peopling the Lesser Antilles. In later days, even as against their ancient Arawak enemies, these Indians descended in hordes upon the incipient colonies on the neighboring islands of Barbuda, Montserrat and Antigua, and their ability to be swallowed up by Waitubukuli's impenetrable forests caused them to repel successfully all punitive expeditions sent against them. In his *History of the Caribby Islands* Davies relates that, "the Caribbeans have tasted of all the nations that frequented them, and affirm that the French are the most delicate and the Spanish are hardest of digestion." In 1640 a raid by them on Antigua resulted in the total pillage of that island, while another barbarous attack in 1666 culminated in the cruel murder of a former governor whose broiled head was carried back in triumph to their retreat on the island of great mountains and innumerable rivers. Only in 1796 was the Carib menace finally quelled.

We sought out a Carib boy to guide us through the island's mountainous backbone from Hatton Garden to Roseau. On this walk my opinion of Carib stamina was raised to a higher level, as that of my own reached an all-time low. I carried only a camera, but our Indian companion, weighted down with equipment considered sufficient to keep him properly tired, still kept up such a fast pace that we had repeatedly to ask him to slow down. Following the Hatton Garden River, now close to its boulder-chocked stream bed, now on a wooded cliff a hundred feet above, we gradually left behind the small cultivated valley floor. Five miles inland saw us up 1,500 feet and in deep mountain forest traversing a trail which sucked us deep into the

SYLVANIA: MOUNTAIN ESTATE
ORANGES GROWN ABUNDANTLY HERE ARE SHIPPED TO BERMUDA AND THE MARITIME PROVINCES.

muckiest of muds. Now and then a distant roar would announce the swift approach of drenching rain—almost the only sound besides the squish-squash of the mud underfoot, or the whine of the guide's dog as he smelled out an agouti or *manicou* (opossum) in the sheltering buttresses at the base of some forest giant.

Peak after peak was surmounted, and long after the sound of the highest rivulet draining to the Pegoua River had faded into silence, the sound of new rivulets ahead announced the passing of the height of land and the descent into the drainage system of Dominica's largest west-flowing, central stream—the Layou. Islanders boast of three hundred and sixty-five streams, one for each day in the year, and anyone who has traveled in the interior forests will certainly authenticate this number. These streams are the founts which nourish the clinging ferns, the pendant red and yellow heliconias of the gorge bottoms, the wealth of epiphytes, the gorgeous evergreen plumes of the soft bamboo. The incessant torrents are the artisans that have carved the island's rugged and precipitous landscape. The myriad

SWINGING BRIDGE OVER THE PEGOUA RIVER
THE LITTLE ISLAND BOASTS OF HAVING OVER 365 STREAMS, "ONE FOR EACH DAY IN THE YEAR."

gorges and breathtaking waterfalls have created the chief obstacles to the encroaching civilizing attempts of man, and at the same time have supplied the inhabitants with fresh drinking water and streams free from breeding spots for malarial mosquitoes. The swirling waters at times eddy into pools which for bathing far surpass the tepid Caribbean.

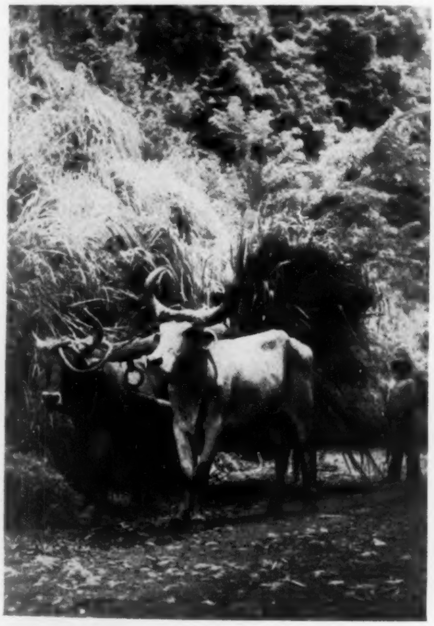
Astride the central island mass, in the lee of the great peak they call Morne Trois Pitons, we stumbled upon an estate fittingly called Sylvania. Upon the mountain slopes, only recently forested, appeared a vision of carefully tended orange groves outlined against a yellow-green sea of delicately scented lemon grass. Ten thousand crates a year of "Tradewind" oranges find their way to Bermuda and Canada from this forest-bound estate, and indeed, in the tempering coolness of these mountain heights, the New-England-born owner has difficulty in keeping his fruit down to a marketable size!

Sylvania house has been justly called the show place of Dominica. From its thatched roof (to deaden the sound of driving rain on the galvanized iron beneath) to its jasmine-sweetened verandas it is every bit a story-book house set on a forest lawn. We spent many pleasant days at Sylvania, which is a dozen miles above Roseau via the newly surfaced Imperial Road—the corkscrew track which lifts one bodily from the Caribbean, jacks one above the khus-khus bordered lime orchards of the Canefield estate into a climate that is vigorous, new, and refreshing.

The rainy season was no time to be climbing mountains and especially not Trois Pitons. Lionel, the woodcutter, had emphasized that. He warned us that we would get bogged down in mud up to our knees, that it would be foggy enough to cut out all views, and cold besides. Despite our best arguments he could not seem to see the point that we had to climb when we could—now—and that we were after plants, not views; if he could have understood, he would still have thought us crazy. Since Sylvania stood nearly at 2,000 feet we were already in magnificent mountain rainforest which covers most of the land lying between 1,500 and 2,500 feet. (Below 1,500 feet is the low xerophytic tropical vegetation common to

many of the Antilles, while above 2,500 is the region of dwarf mossy-forest.) Unlike most temperate forests which are homogeneous, containing as they do but a small assortment of tree species, this tropical rainforest is heterogeneous, composed of innumerable species. In such a forest almost every tree seems to be different. All are evergreen hardwoods, the most prominent of which are known locally as *gommier* (*Dacryodes*), *chataignier* (*Sloanea*), *carapite* (*Amanoa*), *bois côte* (*Tapura*), and *bois diable* (*Licania*). Boles ten feet in diameter are common, and many of the trunks of these giants are thrust two hundred feet into the air from bases that flare like the flying buttresses of continental cathedrals. Arboreal foliage is so high above one's head as to defy recognition, but from this canopy drop the cord-like roots of *kaklin* (*Clusia*), a common strangling arborescent epiphyte. On the trees appear numerous vines, such as marcgravias, *zelle mouche* (*Carludovica*), which lift their festooning cables to the sunlight, while lower down are aroids and ferns clutching at every foothold. Beneath the trees the light is dim and ground vegetation is never dense. A rubiaceous shrub (*Cephaelis*), with tiny white flowers surrounded by waxy blue-bracts, is most common living among colonies of low ferns, feathery selaginellas, or occasionally with various rare terrestrial orchids. But colorful plants are few and over all is just the leaf green of the forest.

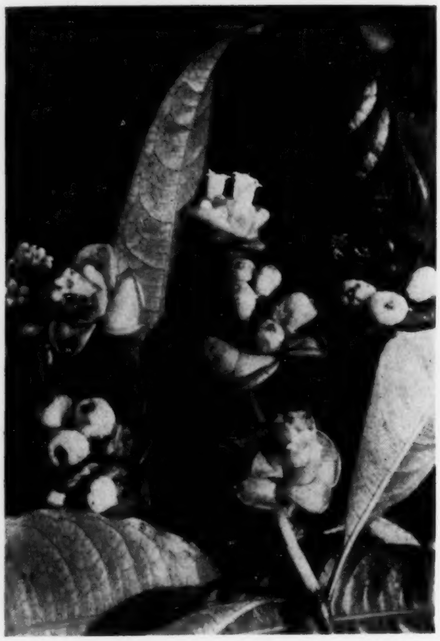
A VIEW IN THE MOSSY FOREST
THE MOUNTAIN FOREST'S IMPENETRABLE GROWTH IS COVERED WITH MANY TYPES OF EPIPHYTES.



FRAGRANT LEMON GRASS
GROWN IN LIME ORCHARDS FOR GREEN MANURE.

Following a woodcutter's trail we found ourselves in the twilight of this solemn cathedral setting where the choristers were the various thrushes and the mountain whistler (*sifleur montagne*): a solitaire whose clear flute-like notes, combined with the gurgling cadenzas of a Dominican wren, offered fitting accompaniment to the unusually quiet green pageantry spread around us. Here also is the home of two rare parrots—"Jacquot," or *cicerou*, and the Imperial (largest of its kind in the world)—which commonly flush from the *bois diable* or *pipiri* trees on whose fruits they are accustomed to gorge. Besides this game, woodsmen hunt pigeons (*ramier, tourterelle*, or *perdrix*) as well as wild pig, agouti, or opossum (*manicou*).

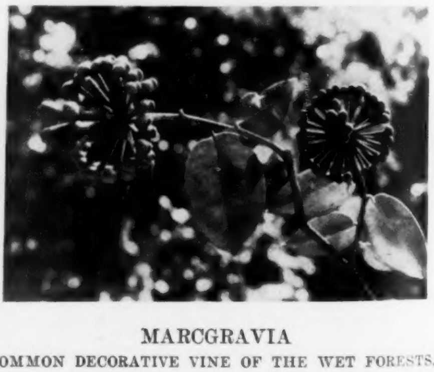
One has to become an acrobat on the uppermost grueling slopes of Dominica's mountains, for here the constant trade-wind causes the forest aspect to change. The trees are of



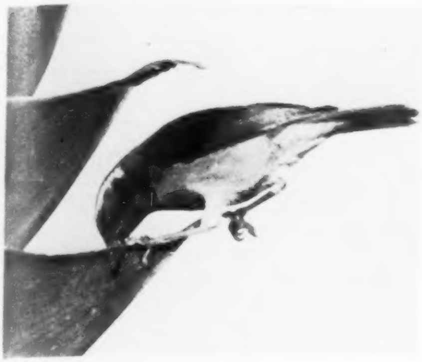
CEPHAELIS SWARTZII
THE FOREST'S COMMON UNDERSHRUB HAS WHITE FLOWERS SURROUNDED BY WAXY BLUE-BRACTS.

different species and are dwarfed, twisted, and massed in impenetrable and grotesque fashion upon the steeply pitching slopes in such a way that one can only make progress by clambering hand over hand through the appressed, dripping, wind-blown treetops. Rain here, except on rare occasions, is almost incessant, with the result that mosses are everywhere, covering the limbs like cushions and spilling out water at every touch; their presence in such numbers gives to this upper region the name mossy-forest. Great bromeliads are astride every tree, while delicate threads link the dainty fronds of the many elfin filmy ferns. Only in very restricted areas is this low forest absent, and here the rocks are covered with bromeliads, mosses, creeping lycopodiums and a beautiful purple-flowered dwarf shrub (*Tibouchina*). We soon learned why Lionel had so quailed at coming. He sat, while we collected at the summit, a shivering example of dejection. To us it was not cold, perhaps sixty to sixty-five degrees, and yet on that misty, cloud-shrouded summit he was probably experiencing the coldest weather of his island life! To gain the actual summit of most of Dominica's peaks one has carefully to follow the course of some steep ridge that in many cases is so sheer as to form a knife edge which almost can be straddled. On another occasion we revisited Trois Pitons' summit and were blessed with a miracle in weather—full sunlight on a peak whose summit contours were practically unknown. Such weather permitted the taking of the first photographs which really show the summit configurations of Dominica's little known and inaccessible peaks. Visitors to Dominica's interior have been few, with the result that it is a paradise to the plant collector, and indeed the best "pickings" on the island were from Trois Pitons' upper slopes. Here were discovered, besides other rarities, a fern, three shrubs, and two palms—all new to science.

It was easy to descend the steep slopes, for with mud-oiled pants it was a quick downward slide on slippery clay! Back at Sylvania the sun had already slid behind the slopes to the west and an insect chorus was ushering in the night. At no other time are Dominica's forests more lovely; from the sheaths of the palm leaves comes the "crack-crack" of the huge katydids; high up in the plumose bamboo the blacksmith beetle sends down clear notes like the sound of a hammer on a tiny anvil; while on every side are the myriads of tiny lanterns of the island's astounding fireflies. These woodland fairies, the "labelles" of the natives, are tropical giants among lightning bugs, and when "afire" look like tiny automobiles moving in the darkness with two headlights and a taillight behind. The lights of just one of these creatures are bright enough to enable a person to read, and in the days when the island



MARCGRAVIA
COMMON DECORATIVE VINE OF THE WET FORESTS.



A WEST INDIAN BULLFINCH
CAUGHT DRINKING FROM A *Heliconia* BRACT.

was known as Waitubukuli the Carib owners employed these woodland gnomes for many a useful purpose, attaching them to their feet and hands when traveling after dark; using them instead of flambeaux on hunting and fishing expeditions. Furthermore, the mashed bodies of labelles possess for a short while the qualities of a phosphorescent paint, and Indian war parties are said to have supplanted the red anatto warpaint of daylight with firefly phosphorescence, thus terrifying their enemies with "flaming countenances."

After such a day's revel in the mountains, when tropical night silences all but insects and thoughts, it is easy to agree with William Palgrave, the great writer and traveler, who wrote, after visiting Dominica in 1876:

> In the wild grandeur of its towering mountains, some of which rise to five thousand feet above the level of the sea; in the majesty of its almost impenetrable forests; in the gorgeousness of its vegetation; the abruptness of its precipices, the calm of its lakes, the violence of its torrents, the sublimity of its waterfalls, it stands without a rival, not in the West Indies only, but, I should think, throughout the whole island catalogue of the Atlantic and Pacific combined.

THE MOUNTAIN WHISTLER OF DOMINICA

It is while carefully balancing myself on my shaking support of matted roots, that a sound comes to my ear through the roar of a waterfall—a sound strangely sweet, solemn, and impressive; a mellow, organ-like note, clearer than any flute-tone, more thrilling than the solemn chant of sacred song in groined cathedral. It is repeated. I stand entranced, listening to melody that had never fallen on my ears before. The cause I cannot at first ascertain, for the notes seem ventriloquial; and indeed they are so, for I search high and low, the leafy branches above my head, the densely clustered ferns at my feet, and the shrubs at my back, for many minutes, before I find the source of this mysterious music. Balanced airily on a lance-like bamboo that shot twenty feet beyond the brink of the cliff, poised in mid-air, with half a thousand feet of space between him and solid earth, is a daintily-shaped bird, clad in sober drab, save a dash of rouge beneath his throat, and of white here and there.

Unconscious of surrounding things, animate and inanimate, he was devoting his powers to the production of that wonderful music. . . . Surely no flute ever produced such mellow, liquid tones. It was music of unearthly sweetness, that, once heard, would never be forgotten—between the notes a long pause, that made them most impressive. It was not a song—though I discovered later that the little bird had a song—but simply the utterance of a few notes. Soon it ceased, and the bird flew into the near forest, where I soon discovered it busily feeding upon the berries of a tall shrub, to the pendant branches at which it was clinging, now and then dashing at a fugitive bunch, apparently as absorbed in this occupation as in his melodious lay of a few minutes before. Soon he ceased feeding, and commenced preening himself upon a naked limb; then, after smoothing himself out, as it were, and drawing in and stretching out his neck, he suddenly dashed at a single berry, swallowed it to clear his throat, and recommenced to trill. He had uttered but a few notes when he silently flew to a dead branch; a few more and he winged his way to a swinging "liane," where he hung suspended above a little ravine, in which is sunk a tiny stream, whose tinkling waters made music, though not so sweet and liquid as his. Then he disappeared in the dark recesses of the forest, where it would be useless to follow him, but whence came at intervals the ventriloquial music that seemed to float over my head and around me, though the bird was afar.

This bird is called by my mountaineer friends, who have a name, and an applicable one, for everything in the forest, the "*Siffleur Montagne*," or "Mountain Whistler."

—From *Camps in the Caribbees: The Adventures of a Naturalist in the Lesser Antilles*, by Frederick A. Ober, Boston, Lee and Shepard, 1880, pp. 19–20.

ENGINEERING IN MEDICINE*

By ALVAN L. BARACH

In discussing applications of physical principles to clinical medicine and, for the sake of illustration, to aviation medicine also, I shall stick to the narrow bridge which I have crossed between these principles and the treatment of respiratory illness. Needless to say there are other more remarkable examples of the relations between physics and medicine, but I feel less likely to fall into the abyss of fanciful conjecture if I stay for the most part within the boundary of my own experience.

I

Two decades ago the physiological basis for administering oxygen to patients with respiratory illness was being placed on a solid foundation, but comfortable and effective methods of providing oxygen-enriched air, containing two or three times the normal percentage of oxygen, were yet to be developed. A funnel held in front of the face was then the most common appliance, but it was almost worthless and generally used as a gesture of last resort. The mask of Haldane and rubber tubes inserted into the nose were more effective, but any appliance fastened to the face was found objectionable by many patients. The clinical value of oxygen therapy could not be established by using methods that were ineffective in overcoming the lack of oxygen from which the patient suffered, or that were uncomfortable or objectionable in application.

An oxygen tent designed by Leonard Hill consisted simply of a canopy over the patient, but since it did not provide for eliminating heat and moisture it produced a warm and humid atmosphere. Our early attempts, with Binger and Roth, to remedy this situation by passing air through copper pipes packed in ice for cooling, and through soda-lime and calcium chloride containers for removing water vapor, failed to provide a hygienic atmosphere in respect to temperature, humidity, and air movement. The idea of blowing an oxygen-enriched atmosphere directly over chunks of ice contained in a refrigerating cabinet seemed to possess theoretical advantages because a wide surface area of a cooling medium was obtained with minimal resistance to the circulation of air. In the first actual trial after the copper pipes were removed and pieces of ice were inserted in the same container, the effect on the patient was remarkable and almost instantaneous. With the increased comfort provided by cool, dry air he relaxed and fell asleep—the beneficial effects of oxygen therapy were no longer obscured by factors which interfered with his well-being in other ways. Further improvements in accessories were necessary, such as transparent canopies (Fig. 1) and noiseless motors, but the main objective had been achieved in an obviously simple way. The temperature of the air dropped 15° F. and the relative humidity 25 percent. The oxygen tent from that time on was capable of offering the patient not only an atmosphere of forty to sixty percent oxygen, but also one that was hygienic in respect to temperature, humidity, and air movement.

Oxygen rooms had previously been constructed by Barcroft and Stadie which were ventilated by motor-fan units and which were sufficiently leak-tight to permit the maintenance of an oxygen concentration above fifty percent. Rigid care had to be taken to prevent sparks in an atmosphere in which a high percentage of oxygen was present. Partly to avoid this danger, a simpler method of ventilating a room was developed in which no electrical contrivance was necessary. When series of one-inch pipes were installed across one side of a room with either ice water or brine circulating through them and a steam radiator was placed on the other side of the room, thermal circulation, cooling,

* From the Department of Medicine, College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital, New York; sponsored by the Committee to Study Air Conditioning, American Medical Association, Carey P. McCord, Chairman, Alvan L. Barach, Commander W. M. Simpson, and C. P. Yaglou. The illustrations for this article are from a forthcoming book, *Principles and Practices of Inhalational Therapy* (J. B. Lippincott), by the author.

and dehumidification of air were satisfactorily obtained. This type of ventilation had the advantage of being noiseless and usable in any room that could be made leak-tight. Oxygen rooms of this type (Fig. 2) have been in use since 1925, at first in the old Presbyterian Hospital, New York City, and now at the Columbia-Presbyterian Medical Center, without any fire or other untoward difficulty.

Transportable oxygen rooms (Fig. 3) have been installed in private homes in which patients have lived for the greater part of both day and night for months and even for years. Although cure of chronic pulmonary disease is not effected by oxygen treatment, betterment of respiratory function, relief from labored breathing (dyspnea), increased comfort, and prolongation of life may be accomplished.

Helium was later introduced as a therapeutic gas partly because it is chemically inert and does not form an explosive mixture with oxygen, but principally because it is lighter than any other element except hydrogen. A mixture of eighty percent helium and twenty percent oxygen has a density of only one-third that of air or oxygen. Since the velocity of gas movement by effusion or diffusion through a constricted orifice is inversely proportional to the square root of the molecular weight of the gas, it follows that such a lighter-than-air mixture can be breathed in conditions of obstructive dyspnea with about one-half the effort required for the inhalation of either air or pure oxygen.

FIG. 1. TRANSPARENT TENT FOR THERAPY WITH CONDITIONED OXYGEN

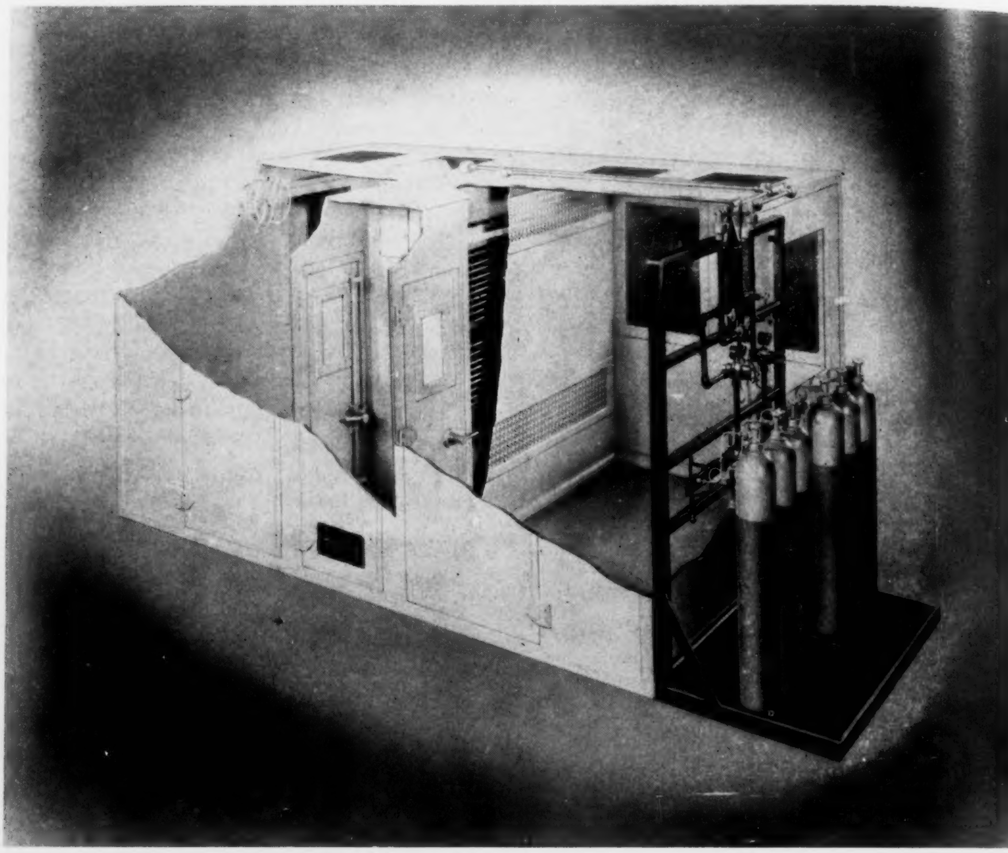


FIG. 2. OXYGEN CHAMBER VENTILATED BY THERMAL CIRCULATION

The inhalation of helium-oxygen mixtures by patients with severe asthma has in many instances been a life-saving measure; as a result of repeated inhalations of helium with oxygen in intractable asthma, bronchial relaxation may take place and, in a number of cases of this type, a state of relatively mild or no asthma has been initiated. This inhalational treatment of asthma is not a cure of the disease, but it is a remedy of such value that it may relieve intractable asthma for periods of six months and sometimes for more than a year.

In conditions of localized obstruction in the upper respiratory passageway a helium-oxygen mixture has also been employed in order to decrease the effort of breathing and to increase the velocity of gas movement. In the use of helium-oxygen mixtures the oxygen tent has not been found effective, since this gas readily leaks through the points of contact which the tent makes with the bed. Although this gas can be used with a mask, a helium-oxygen helmet hood (Fig. 4) was developed which enclosed the head of the patient, making contact at the neck. When a positive pressure of two to five centimeters of water was maintained within the hood it was soon found that breathing became remarkably more comfortable. Very severe cases of obstructive dyspnea, both asthma and lesions in the larynx and trachea, have been controlled in this way.

II

The stimulus which led to the use of positive pressure in bronchial asthma originated from an observation that one of our first patients who was treated by helium-oxygen therapy habitually breathed in such a way as to create an obstruction at his mouth during expiration. With his lips partially

closed, he would slowly blow out against an arbitrarily imposed and very obviously narrowed orifice. When I suggested that he was making his breathing harder and that he should open his mouth to breathe, he lapsed into a state of uncontrollable asthmatic dyspnea, indicating that his manner of breathing had some functionable significance.

When, in cooperation with Swenson, lipiodol was inserted into the lungs of a patient with bronchial asthma, the X-ray showed that, if the patient was exhaling under a positive pressure, the bronchial tubes did not constrict so much as they did in ordinary unobstructed expiration. With that hint in mind, patients with helium and oxygen in the hood were exposed to a continuous positive pressure in the helmet of three to six centimeters of water. This small degree of positive pressure during expiration was reflected back into the respiratory passageway and prevented the bronchi from collapsing with the result that the decrease in the total volume of lungs during the expiratory cycle was diminished. Of even greater importance was its effect on the inspiratory cycle, since the presence of an additional positive pressure at the entrance of the lung was capable of blowing the atmosphere into the lungs instead of making it necessary for the patient to suck it in through a constricted orifice.

It has been shown by experiments on animals that a high negative pressure develops within the lungs when breathing takes place through a narrowed orifice. When the air is forced into the lung from the outside this pathologically elevated negative pressure, which is produced by forcible contraction of the diaphragm and chest muscles, is much reduced. The disadvantage of the patient's employing a high negative pressure in the chest to suck in air past a constricted orifice is that it exerts a cupping action on the pulmonary capillaries and on the mucous membrane of the bronchi, tending to cause exudation of mucus and serum. In some instances

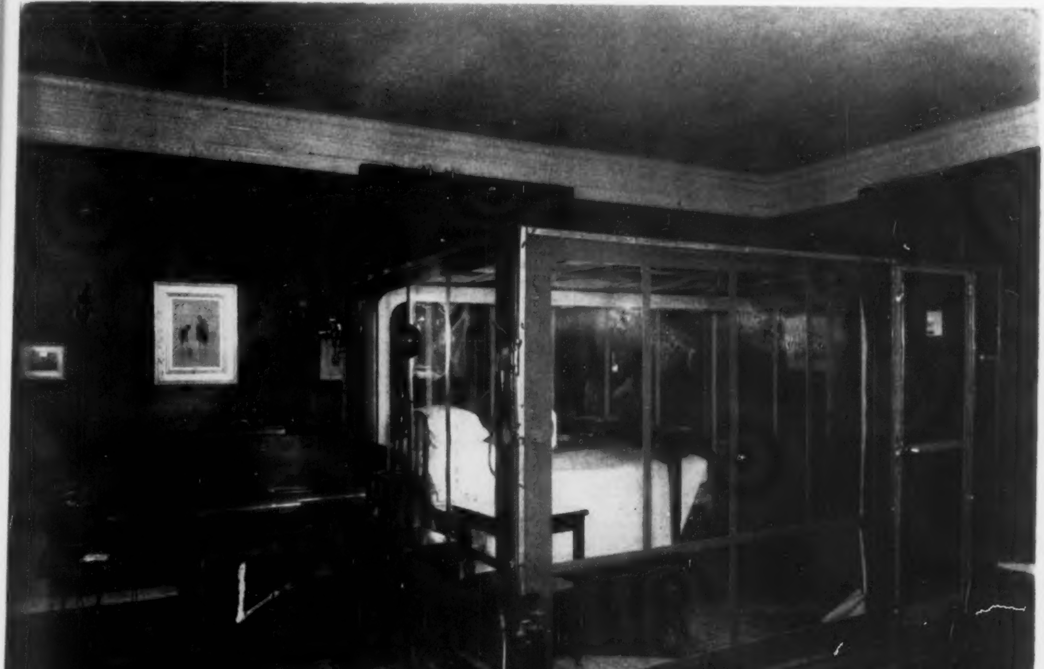


FIG. 3. PORTABLE OXYGEN CHAMBER FOR USE IN HOMES

such a pulmonary edema takes place in human beings as a result of long-continued respiratory obstruction. Edema of the lungs was consistently produced in animals by having them inspire through a constricted orifice, or against a negative pressure of six centimeters of water.

As long ago as 1878 Oertel employed one hundred inspirations under positive pressure in the treatment of asthma, and Haven Emerson, in 1909, showed by experiments on rabbits that artificial respiration conducted under pressure prevented or cleared edema of the lungs due to previous injection of adrenalin. Other observers, such as Auer, Loeb, and Gates, confirmed these observations. However, little or no clinical application had been made of them, except with the apparatus of Plesch used by Poulton.

The helium-oxygen hood offered a comfortable and effective way of providing positive pressure in conjunction with gas therapy. A number of cases in which there was a marked outpouring of serous fluid from the capillaries of the lung into the air spaces were treated by positive pressure with a resulting swift clearing of the edema in a number of instances. In some cases there was a prompt recovery from what otherwise would have been regarded as a fatal illness. A mask for the application of positive pressure during inspiration and expiration is shown in Figure 5.

A result of pressure applied to the outside of the capillaries in the lungs is to counteract directly the internal hydrostatic pressure in the blood vessels. This opposing exterior pressure retards the tendency of the capillaries to ooze when there is either an increased pressure within them, as in heart failure, or some change in permeability of the capillaries, as in pneumonia or gas poisoning. Another effect of positive pressure within the chest may be to retard the inflow of blood into the right heart. In cases of cardiac failure such a pressure allows the heart to work with a diminished volume of blood. In normal individuals the increase in venous pressure largely compensates for the retarding effect of the increased physical pressure in the lung, as is proved by the fact that the circulation time was found generally maintained near its normal level.

More recently an apparatus has been developed in which positive pressure in expiration alone has been provided. In collaboration with Eckman and Molomut, I have used a mask apparatus in which expiration proceeds through a tube immersed in a water bottle or through a flutter valve surrounded by a metal disc that is punctured with orifices of various sizes. In the largest orifice there is no resistance to expiration, but as the disc is moved to smaller and smaller orifices the resistance to expiration becomes greater and greater. This mask (Fig. 6), employing positive pressure in expiration, has been used in the treatment of clinical pulmonary edema, and also by Carlisle in the edema of gas poisoning from fumes of chlorine or nitric acid.

The foregoing experience points to the possibility that breathing against a positive pressure may aid in overcoming the consequences of pulmonary irritant war gases. In the absence of oxygen a mask of this kind may be used to advantage simply by removing the collecting bag and inspiring air through the inspiratory valve, and exhaling it through the expiratory valve and the selected narrowed orifice. In the absence of a mask, expiration through a cigarette holder can be used and has, in fact, been reported as an emergency measure in the clearing of pulmonary edema in two clinical patients.

It appears, therefore, that there is a functional significance in grunting and groaning by patients with respiratory illness, although these symptoms are ordinarily thought of as subjective complaints. A characteristic symptom of lobar pneumonia is an expiratory grunt, in which the patient at the beginning of expiration holds his breath, closes his glottis, develops an increase in intrapulmonary pressure, and then gradually exhales in a grunting or groaning form of breathing. I have a memory of many years ago when I had a patient, ill with lobar pneumonia, who grunted and was suffering considerably. I gave this patient two doses of morphine which stopped the expiratory grunt but he lapsed into edema of the lungs.

My conclusion is that the expiratory grunt is a beneficial action, and that consequently it is justifiable to speak of the physiological

FIG. 4. HOOD FOR ADMINISTRATION OF MIXTURES OF HELIUM AND OXYGEN

advantages of grunting and groaning. Where patients who have had a long-standing obstruction of the larynx are suddenly relieved by making an incision into the windpipe, they will often develop exudation of serum and mucus from the pulmonary capillaries and from the bronchi. This exudation can be controlled by having these patients inspire normally and expire under positive pressure, as shown by Woodman and later by Kernan and me.

In the mask apparatus mentioned above, variable concentrations of oxygen can be obtained by the use of an injector attached to the regulator. As oxygen passes through it in a swift stream, a negative pressure is developed within the metal injector which draws in a variable amount of outside air, depending upon the size of the orifice open to the atmosphere. Calibration of these orifices in experiments made possible the instantaneous provision of oxygen concentrations between forty and one hundred percent with an error not exceeding three percent.

III

I now pass to the consideration of a method for immobilizing the lungs that is also based on an application of engineering principles. In 1926 Thuneberg showed that an apparently adequate pulmonary ventilation could be maintained in case of respiratory paralysis by placing the patient in a chamber in which an alternating pressure of one-sixth of an atmosphere above and below normal was used. Drinker and his collaborators then developed the respirator, now commonly known as the "iron lung," in which the body of the patient is enclosed in a box with the head protruding outside. When a motor blower unit or bellows creates a suction pressure of fifteen centimeters of water within

the chamber, the chest is expanded during inspiration; when this is turned off, the chest returns to the expiratory position as the result of atmospheric pressure.

My interest in immobilizing the lung was to secure lung rest in patients having pulmonary tuberculosis. An air-tight room was first constructed in which patients could be subjected twenty-five times a minute to alternating pressures of fifty-five millimeters of mercury above and below that of the atmosphere. This change was sufficient to force air in and out of the lungs, but it was soon evident that during the positive phase the air pressure compressed the chest slightly, and that during the negative pressure phase the chest was momentarily expanded. This movement of the chest was traced to the resistance of the tracheo-bronchial tree to the free flow of air, which delayed and decreased the application of pressure to the inner surface of the lung.

An air-tight box was then constructed around the body of the patient, with the head protruding into the original chamber. When small apertures were made in this box, it was possible to retard the application of pressure to the chest to keep pace with the pressure of air in the lungs that had entered through the nose and mouth. In that way we were able to equalize the pressure on both the inner and outer surfaces of the chest wall, and on the diaphragm as well, so that little or no discernible movement of them took place either on ordinary observation or on X-ray examination of the margins of the diaphragm. An adequate movement of gas molecules in and out of the immobilized lung provided a plentiful supply of oxygen and eliminated the carbon dioxide.

After the method of immobilizing the lung had been perfected, a number of persons having advanced pulmonary tuberculosis were given the lung rest treatment. In six of eight cases there was a clearing of the lesions due to tuberculosis and most of these patients are now living or working without any evidence of active infection. Although this method (Fig. 7) of immobilizing the lung is a practical procedure which is comfortable to the patient and has been effective in some instances in promoting a cure of advanced

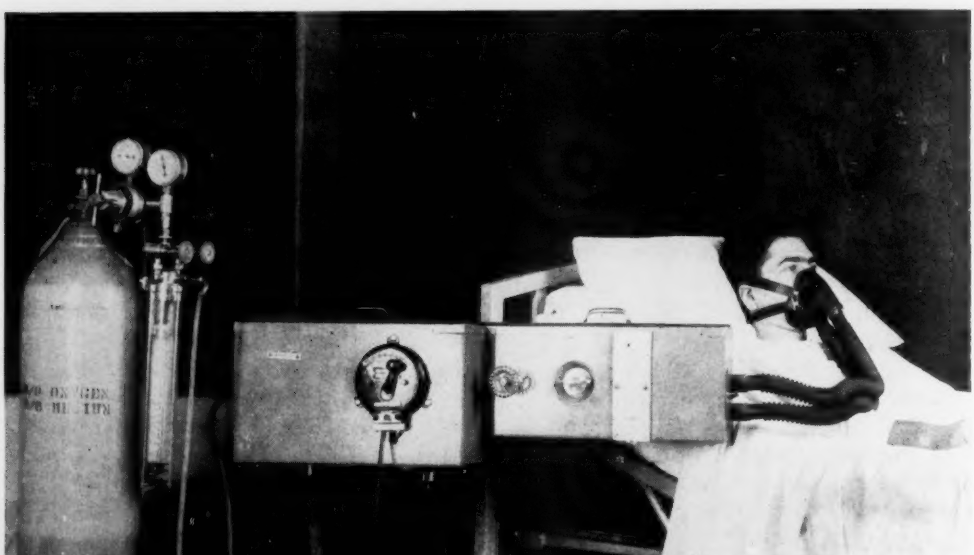


FIG. 5. ADMINISTRATION OF OXYGEN UNDER CONTINUOUS POSITIVE PRESSURE

pulmonary tuberculosis, after other measures had failed, more studies are necessary in order to determine the range of its usefulness.

IV

It will be instructive to consider an illustration of the ease with which physical principles may be overlooked in medical problems, particularly by those whose training is in medicine and not engineering. Such a problem of great importance is now before medical men and engineers.

In dealing with the physiological factors involved in high altitude flying, we are faced first of all with the fundamental fact that a unit of gas at constant temperature expands in proportion to the decrease in pressure to which it is subject. For example, a liter of gas at sea level will expand in the free state to six liters at an altitude of 42,000 feet. Since the volume of the chest is constant, it is evident that even though pure oxygen is inhaled the molecules are so widely separated at very high altitudes as to be unable to provide a normal oxygen pressure in the lungs and, therefore, in the blood and the tissues. One of the interesting characteristics of the human mechanism found under these conditions was that the expansion of gases obscured certain physiological happenings within the body.

TABLE 1

PERCENTAGE BY VOLUME OF OXYGEN, CARBON DIOXIDE, AND WATER VAPOR IN THE LUNGS, AT SEA LEVEL (760 MM. HG) AND AT 42,000 FEET (128 MM. HG), WHEN BREATHING 100 PERCENT OXYGEN

Gas	Sea level	Altitude 42,000 feet
Oxygen	88.5	35.2
Carbon dioxide	5.3	28.1
Water vapor	6.2	36.7

At sea level the atmosphere has a normal pressure of about 760 millimeters of mercury and at an altitude of 42,000 feet a pressure of about 128 millimeters of mercury. Consequently if ordinary air is breathed at such a great altitude, or in a decompression chamber having corresponding conditions, not enough oxygen will be available in the lungs to sustain life. Since only about twenty percent of the atmosphere is oxygen, it is natural to assume that its deficiency in the lungs at high altitudes, even up to 42,000 feet where the atmospheric density is only one-sixth that at the surface, can be largely restored by breathing pure oxygen. This would be the case if it were not for certain other interesting and important physical aspects of the problem which experiments forced us to consider.

FIG. 6. OXYGEN METER MASK
CONTROLLING POSITIVE PRESSURE DURING EXPIRATION.

The tube through which aviators breathe oxygen from containers at high altitudes must not be gas tight at both ends, for otherwise the pressure on the interior of the lungs might become much greater than the atmospheric pressure on the outside with disastrous results. Consequently at every altitude aviators must breathe gases having the same density as the surrounding atmosphere. There could be an exception only if they should be enclosed in air-tight cabins in which the pressure could be kept above that of the exterior air.

When an aviator inhales pure oxygen his lungs are filled partly with oxygen, and partly with water vapor and carbon dioxide released into them through the capillaries of the circulatory system. There is such an abundance of water in the blood that the lungs are always saturated with water vapor. The amount of water vapor for saturation depends upon the temperature but, contrary to what might be expected, is independent of the amount of other gases present. Therefore, since the temperature of the lungs is the same whatever the altitude, the amount

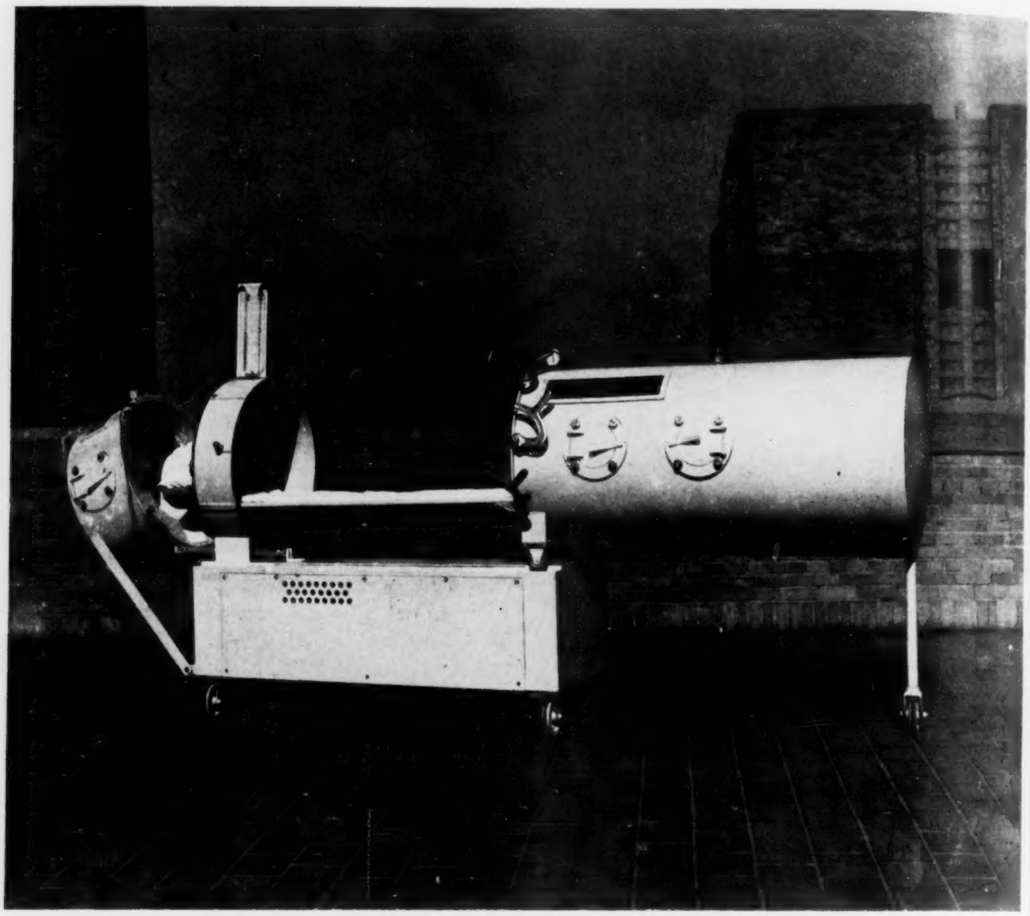


FIG. 7. EQUALIZING PRESSURE CHAMBER FOR IMMOBILIZATION OF THE LUNG

of water vapor in them at high altitudes is the same as at the earth's surface. Since the oxygen in the lungs decreases with altitude whereas the water vapor remains constant, the relative percentage of water vapor increases. At sea level water vapor constitutes about six percent of the contents of the lungs; at an altitude of 42,000 feet this percentage rises to about thirty-six (Table 1).

Conditions are similar with respect to carbon dioxide. At sea level the percentage of carbon dioxide in the lungs is a little over five, whereas at a pressure corresponding to an altitude of 42,000 feet it is twenty-eight.

With the results at hand for both water vapor and carbon dioxide in the lungs, we can calculate the relative oxygen content of the lungs of an aviator breathing air at sea level and pure oxygen at an altitude of 42,000 feet. On taking these factors into account, it is found that an aviator gets considerably more oxygen when breathing air at sea level than he does when breathing pure oxygen at an altitude of 42,000 feet, or in a decompression chamber with an atmospheric density the same as that in the open air at an altitude of 42,000 feet. This result indicates that in order to ascend to great altitudes the personnel will have to be enclosed in airtight cabins in which atmospheric pressures can be maintained above that of the exterior air.

In the course of our determinations of "vital capacity" at different altitudes, a phenomenon was met that was puzzling until the explanation occurred to my colleague, Mr. Eckman. Vital capacity is the maximum volume of air a person can expel from his

lungs after inhaling deeply. This maximum capacity of a person is measured by his first taking the fullest possible inspiration and then exhaling it as completely as possible into a spirometer, which measures the amount of air admitted into it. Evidently the lung capacity of a person is the same at all altitudes. But when the vital capacity of a man was found to be 5,000 cubic centimeters at sea level, a test would show it to be about 4,000 cubic centimeters at a pressure corresponding to an altitude of 42,000 feet. Mr. Eckman noted that the exhalation was from the lungs at temperature of 99° F. into a spirometer at a temperature of 68° F. Since in the lungs the vapor pressure of the water would always be the maximum possible for the temperature, condensation would follow the exhalation into the cooler spirometer. As is shown in Table 1, at sea level only six percent of the air in the lungs is water vapor, while it is thirty-six percent at an altitude of 42,000 feet. Therefore the water condensed at the higher altitude would be a much larger fraction of the contents of the lungs than at sea level. An experiment in which the subject breathed into a spirometer at 99° F. gave the same value for the vital capacity at both altitudes and verified the theory.

There are many other examples of applications of physical principles in clinical and aviation medicine, but those that have been presented from actual experience are sufficient to illustrate the importance of broadening the base for medical education. Heretofore students have generally entered medicine through the avenues of biology and chemistry, whereas those taking physics have preferred engineering. Wider horizons are needed.

Beware of the generalist who is not a specialist but beware of the specialist who is not a generalist.—Blake.

RACE AND PUBLIC POLICY

By LOUIS WIRTH

ACADEMIC men are inclined to ascribe an importance to knowledge all out of proportion to its actual role in human conduct. This is particularly true of race relations. Men do not wait until the latest findings of science are in before they begin to feel, think, or act on matters that concern race; and even when new scientific findings come to hand it does not follow by any means that people will promptly change their beliefs and actions to conform to them.

Race and Reason. This is not to argue the futility of the search for tenable knowledge about race and race relations, but merely to indicate the limits of its effect upon practice. In the beginning was the act, not the thought. Frequently, however, men cling tenaciously to a belief even in the face of overwhelming evidence of its falsity. They often persist in a type of conduct which is flagrantly contradicted by both the factual premises upon which it supposedly rests and its practical outcome. And yet, if we are pursuing the quest for knowledge for any other reasons than its own sake, we must assume that ultimately, if not always, knowledge does make a difference. Many illustrious examples from history support this assumption.

Although the displacement of superstition and dogma by science, even in the fields of technology and medicine, to take but two instances, has by no means been as rapid and as automatic as might be wished, in social affairs, in matters that affect religion, the family, nationalism, and race, scientific findings have made their way into belief and action even more slowly. This appears to be due not merely to the supposed fact that scientific findings in these latter fields are less certain and more personal, but rather to the circumstance that established beliefs and practices in these matters have an almost sacred character and are not subject to secular, objective scrutiny. In matters of race even a Hitler or a Goebbels may pose as an expert and be accepted as such by millions, whereas probably no one would accept them as experts in medicine or engineering. We must assume, nevertheless, that the search for truth by the methods of science is at least as important in the realm of the social as it is in the realm of the physical and biological and that ultimately here, too, the truth shall make men free.

The Nature of Race Prejudice. What we know and what we do not know about race would be merely a prosaic academic matter if it were not in the minds and actions of men associated with some of the most acute practical problems of human relations in our day. These problems range from personal idiosyncrasies and antipathies to violent mass conflict and the clash of national and international policies. It is the latter type of problem that constitutes the subject of this paper. But before treating the subject of race and public policy, a word needs to be said about race relations as personal relations.

All of us have our likes and dislikes, our preferences and antipathies. We prefer certain foods over others; we have our personal tastes in clothing and furniture; we ride hobbies and have our blind spots in art and in recreation; we have our passionate affections and our equally deep-seated revulsions toward other persons. All of these, however, are matters of little if any public concern. We regard them as private affairs.

Our tastes, our preferences, and our antipathies, however, are not altogether of our own making and the result of our own personal experiences. For the most part our personal pattern of race relations is made for us by the culture in which we live, just as our behavior patterns in other respects bear the imprint of the group to which we belong. We have preconceived attitudes toward objects and persons that we have never met. These attitudes tend to be more verbal than actual. It is difficult for us to work up very much enthusiasm for, or antagonism against, people whom we have never seen, although we may have stereotyped notions about how we are to react to

the symbols representing these unfamiliar persons. In a race-relations survey made some years ago on the Pacific Coast, a considerable proportion of native-white Americans who were questioned exhibited a markedly distant and unfriendly attitude toward Turks, although probably few, if any, of those who held this attitude would recognize a Turk if they met one. Strange as it may seem, the genesis of this attitude may be in part the inadvertent by-product of the Sunday school experience which many American youths underwent when they dropped their pennies in the collection box to save the persecuted Armenians from the "Terrible Turk."

Prejudices are judgments that we pass on objects or persons before we have had any experience which would give us reasonable grounds for feeling or acting as we do. These "pre-judgments" are the result of our predisposition to lump objects or persons together into classes or categories irrespective of their individual differences or merits. When we treat one person cordially and as an equal, and another in a hostile fashion or as an inferior because the former belongs to our race and the latter to a different race, we are exhibiting a racial prejudice. Whenever we hear people say, "I don't like Americans, Englishmen, Russians, Negroes, Jews, Catholics because they do so and so," we may be sure that what follows the "because" is an attempt to justify on rational grounds an attitude which rests upon emotional bias. No people as large as any of the groups mentioned above are so much alike that the same judgment could conceivably apply to all of them. Our pre-judgments of other people, especially of racial and ethnic groups, are not rationally examined in the light of our own experiences with a substantial number of members of such groups. They are for the most part imbibed by us from the popular beliefs held in our own group, sometimes transmitted unconsciously by our elders and our neighbors through example, sometimes the product of education and not infrequently of deliberate propaganda. The fact that there is no rational or experiential justification for these beliefs, however, does not make them any the less potent.

To most white people all Negroes look alike. Most Americans, even now, find it difficult to tell the difference between Japanese and Chinese, between Koreans, Filipinos, and Puerto Ricans. Only when we get to know certain members of these groups intimately do we begin to distinguish between individuals and to note that there is as much difference between different persons in each of these groups as there is between persons in our own group. Just as we ascribe identical physical traits to them, so we are inclined to ascribe identical mental, social, and moral traits to people whom we know only by their racial labels. Thus, for instance, we attribute a racial odor to Negroes because we have met one or a few individuals whose smell offended us. We forget that perhaps white individuals working in the same occupations or living under comparable conditions might have an equally offensive odor. We meet a member of another racial or ethnic group who cheats us in a business transaction and we immediately ascribe his dishonesty in business to his race, forgetting that if someone of our own group cheated us, we would blame only the individual and have no thought of race. We see someone who is aggressive, and if he belongs to another racial or ethnic group we blame his race for it. It is a curious fact that we are less inclined, when we see something we like in a person of another race, to give his race credit for the asset, which, of course, is only an individual merit. Thus once a prejudice toward a racial or ethnic group gets started, it tends to be cumulatively confirmed by subsequent experience, and to blind us against all experiences that might prove the opposite.

The Genesis of Race Prejudice. Racial prejudice is associated with the disposition on the part of virtually every human group to think of itself as superior to outsiders. The notion of chosen people is quite widespread. We know of primitive communities the members of which call themselves "men" or "human beings" to distinguish themselves from all outsiders who are regarded as not quite human. We generally glorify the people whom we speak of as "we," whereas the "others" or outsiders are depreciated and suspected. Although strangers do sometimes

have a romantic fascination for us, more often than not we fear them and remain at a respectful distance from them, ready to believe almost anything about them to which we would not for a moment give credence if it concerned a member of our own group. Particularly where these strangers are distinguishable from our own group by such visible marks as color, the tendency to retain them in a category apart is persistent.

Racial prejudices may have their foundation in our own insecurity, be it economic or social. We are reluctant to enter into competition or rivalry with members of groups distinguishable from us by marked physical or cultural characteristics. And when we do compete with them, we are likely to attribute our own failures and shortcomings to some unfair advantage which the others are taking of us, or to our reluctance to put forth our best efforts against unequals. It has been repeatedly found by students of Negro-white relations in the South that the so-called white aristocracy shows less racial prejudice than do the "poor whites" whose own position is relatively insecure and who must compete with Negroes for jobs, for property, for social position, and for power. Only those who themselves are insecure feel impelled to press their claims for superiority over others. This is confirmed by the fact that racial prejudices and conflicts flare up most violently in periods of economic distress when there are not enough jobs to go around. Similarly, when an ample supply of housing is available, people will generally settle in areas where life for them is most congenial and where they can afford to live. But when housing facilities are limited, the Negro may find it difficult to obtain living space, especially when it involves displacing whites.

It takes an exceptionally objective person to accept responsibility for his own failures and frustrations. It is much more convenient to put the blame on another and to invent a scapegoat, especially if that scapegoat has already been groomed for the role by history and circumstance. In the southern part of the United States it might be the Negro; in the Southwest it might be the Mexican or the Indian; on the Pacific Coast, the Oriental; in the great cities, the immigrant or the Jew. We choose as whipping boys those who are easily accessible, easily identifiable, relatively defenseless, and who give us a plausible provocation by actual or imagined competition.

Once a prejudice has become established it tends to perpetuate itself. It becomes part of the atmosphere to which we are exposed from infancy on, not only by what we are officially taught, by what we read, and by what we hear in conversation, but also by subtle gestures and jokes. The desire to conform to what the "best people" do, believe, and say is strong in all of us, and if they happen to hold these prejudices, we tend, though quite unconsciously, to emulate them. Furthermore, these prejudices hold us at a distance from the victims of the prejudices. We never give ourselves a chance to meet on intimate terms those against whom we are prejudiced. If by circumstances we are thrown in contact with them and find no confirmation of our prejudices, we tend to regard these individuals as exceptional cases and still go on believing that others of that race fully deserve the treatment they get. On the other hand, when we meet a member of a race against whom we do not hold prejudices and find him obnoxious, we either never identify him with the group to which he belongs or treat him merely as an obnoxious and unfortunate individual. The groups against whom we hold prejudices, therefore, start out with an initial handicap in their relations with us which they are rarely given the opportunity to overcome. The burden of proof that they are not obnoxious and inferior is upon them.

Being thus regarded as inferior and being excluded from free association and from equal opportunities, the members of a racial group who suffer from prejudice may come not only to feel inferior but also, through unequal opportunities and rewards, actually to be inferior. Correspondingly, the holders of the prejudice may become confirmed in their smug feeling of superiority by being able to point to the evidences of their own superior achievement.

There is no evidence to show that race prejudice is any more inherent in human beings than tastes, preferences, and aversions in other matters. Race prejudice is not an instinct nor an innate tendency, but

an attitude which has to be acquired, a mode of behavior which has to be learned. New-born infants do not have it. Young children are generally free from it, and such experimental evidence as we have leads us to believe that it can be both taught and untaught. The mere fact that in different parts of the world, among different peoples, in different epochs of history, and under differing circumstances these prejudices differ widely should lead us to see how modifiable they are.

Factors Affecting the Decline of Race Prejudice. It is relevant to ask, therefore, what can be done about these prejudices. The problem is not solved by the obvious and oft-given advice that we should get to know members of the other race more intimately. Unfortunately, to know all is not always to forgive all. The more intimate we become with one another, the more, to be sure, we shall understand one another, but it does not follow that the more intimate we become, the more affectionate we become. Intimate knowledge of others may lead us to like them more, but also to dislike them more than we did before.

Students of race relations have noticed that prejudice tends to decline when the group that is the victim of the prejudice is no longer in direct competition with the group that holds the prejudice. The greater the security of a group, the less provocation it has to generate and maintain prejudices against other groups. Some improvement in race relations, therefore, might be expected by minimizing or eliminating the causes of economic and social insecurity among all men.

It has also been found that it becomes more difficult to maintain race prejudice when the members of the group against whom the prejudice is directed are no longer easily identifiable, when the marks—whether physical or social—by means of which we classify and label them fade out. Since the Negro is so distinctly marked by physical traits, the prospect that prejudice toward him will disappear is less than the prospect of the decline of prejudice toward racial and ethnic groups less visibly different from ourselves. But even among Negroes, it should be noted that many thousands of mixed bloods are annually incorporated into the white group, or at least pass among the white group unrecognized as Negroes. The more anonymous our society becomes, the more likely it is that individuals can pass from one side of the color line to the other unnoticed.

Similarly, race prejudice tends to decline when enough exceptions are made. If we have the opportunity to meet a sufficient number of members of the group against whom a prejudice exists who are exceptional, then the rule to which they are the exception is undermined. Self-respecting individuals of a minority group will, of course, be reluctant to accept special treatment. They will not be flattered when someone says, "All Negroes are so and so, but you are an exception," or "I meant no harm, because some of my best friends are Jews." But if the person who holds the initial prejudice meets only persons of the minority groups who are exceptional and none who conform to his stereotype, the stereotype may finally give way. Just as we have attitudes toward Negroes, however, long before we have met a Negro, so we must not expect these attitudes suddenly to vanish once we have the evidence which contradicts them. As our experience which contradicts our stereotypes grows, there is at least the likelihood that our attitudes will eventually be modified. Education, therefore, as it enriches our experience, can become a factor destructive of prejudice.

We have had it reaffirmed recently, if we had not known it already, that race prejudice is likely to decline when the larger group, say the nation, is threatened by an external enemy. When there is an enemy without, the differences within are minimized. Thus, in a period of war we realize more clearly than ever before that racial, religious, and other prejudices constitute a danger to our national unity and it begins to dawn upon us that, however deep-seated our own internal conflicts may have been, they are as nothing compared with the conflicts between us and our enemies.

Consequences of Race Prejudice. Racial, ethnic, and religious prejudices can become seriously divisive forces in society. They are particularly demoralizing in a democracy,

where men profess to believe in equality of opportunity. They make our ideals seem impracticable and impossible of realization. They destroy our belief in our own integrity and our ideals. They tend to make us esteem our fellow men, not on the basis of their individual merit or contributions to society, but on the basis of some fact or alleged fact over which they have no control whatsoever.

Particularly when we are engaged in a struggle against anti-democratic forces do these prejudices become inimical to the national interest. If the dignity and autonomy of the human personality which we profess to respect means anything, it means that we confer status upon an individual, not by virtue of the group into which he was born, but on the basis of his performance. We regard this as one of the principal differences between a caste order—which we began to outlive when we abolished slavery—and a free society. Whereas in a caste order individuals and families occupy a fixed status from which they cannot escape and which they cannot and do not wish to alter, in a society like ours there is, theoretically at least, a possibility of relatively free movement up and down the social scale and there is the ever-present incentive to take advantage of this possibility.

By maintaining racial prejudices we make it possible for our enemies to say "You, too, regardless of your professions to the contrary, practice racial discrimination." What is more, the existence of these prejudices is a factor in undermining the loyalty of the group that is the victim of them. They prevent the nation from gaining the benefit of the maximum contribution and full participation of all of its members in the common cause. Just as they cripple the victim, so these prejudices also warp the holders. They make them blind to what they do not wish to see; they breed arrogance and bigotry; and not infrequently they lead to wanton aggression and unprovoked violence.

Despite the fact that there is no scientific justification for linking the physical characteristics that distinguish the major groups of mankind with intellectual or moral virtues or defects, this linkage constitutes the very heart of race prejudice. Similarly, although there is no justification in science for linking a given language, religion, class, party, or nationality with a given racial group, conflicts that are essentially economic, political, religious, or intellectual come to be regarded as racial. What we do not like about others in our economic, political, religious, and social intercourse, we can, under certain circumstances, attribute to their race. Race prejudice thus comes to be transferred to groups which may not be racial at all. The prejudices derived from one source can be used to reinforce and sustain the prejudices arising from a very different cause.

In the past, racial myths have been invented to account for the rise and fall of empires, to justify and to resist revolutionary movements, to rationalize slavery, war, and imperialistic adventures. Racial prejudices have been used to make discrimination in economic opportunities, in education, in immigration, and in social relations seem just and reasonable. They can be used to weld together peoples who have otherwise little in common, just as they can be used to tear asunder groups which history and a common social heritage have welded into a unity. They have been for a long time and are currently being used by our enemies as a powerful weapon against us in the present World War.

Private and Public Prejudices. While the race prejudices of individuals appear to be largely matters of private concern, they are by no means purely private, either in origin or in their consequences. To the extent that they are the product of the prevailing social stereotypes they can be modified as other collective images are subject to alteration by education and propaganda. They can be affected for good or ill by laws, official practices, and public policy. They can perhaps be dealt with more effectively by indirect than by direct attack, for they are deeply imbedded in the structure of our society and hence can be basically altered only as society itself is altered. Such prejudices do not flourish in a wholesome society where all the members enjoy a substantial measure of security, where no group feels itself exploited and dominated by another group, where group conflicts are at a minimum, or, if acute, are equitably resolved in accordance

with freely accepted rules of the game. In an orderly, stable, prosperous, and enlightened society these prejudices cannot very easily become widely diffused among substantial sections of the people. What is most important, however, is that in such a society it is virtually impossible to build organized movements upon them.

Race prejudices, like all attitudes, are not only contagious but are cumulatively reinforced by the day-to-day social interaction that goes on in a society. Eventually they crystallize into customs and not infrequently they are written into laws. When race attitudes become organized into social movements and thus acquire the vehicles of organizations, ideologies, symbols, and techniques for their dissemination and sanction, they become significant factors in the shaping of public policy. In this manner private prejudices become matters of utmost public concern.

Evolution of American Racial Policy. The United States has not been free from race movements; at different times and in different parts of the country different groups have been the object of organized race prejudice. From its first settlement to the present this nation has followed a succession of public policies involving race discrimination. Our earliest and most dramatic instance of public policy with reference to race emerged with the first contact of the white settlers on this continent with the native Indian population. The indigenous Indians, representing as they did an obstacle to white settlement, found themselves chronically in open war with the whites and were ultimately subjugated by the technically superior invaders. Until very recently the Indians were not allowed to share the rights of citizens, and those who were not exterminated were reduced to the subordinate status of wards of the government and confined to reservations.

Far more important than the Indian, at least from the standpoint of numbers, is the Negro minority in the United States. Ever since the day when he was first imported as an indentured servant or slave from Africa he has constituted the principal stock among our people subjected to both official and unofficial differential treatment based upon difference in race. Since the Negro constitutes nearly one-tenth of our total population and is the principal victim of racial discrimination, his treatment may serve to illustrate the relation between race and public policy.

Neither in the American Colonies nor in the newly formed nation was the Negro included among those who enjoyed the rights of citizenship and equal protection of the law. He was assigned to an inferior place and in general remained in the place assigned to him, although sporadic rebellions testify to the fact that he did not always meekly accept his position as permanent. During the period of slavery the Negro was effectively subordinated to the whites by custom, public policy, and law. To be sure, not all Negroes nor all slaves were treated alike. Some slaves either purchased or were granted their formal freedom. The house servants were on the whole in a more intimate personal relationship with their masters than were the field hands, and the treatment of the former was considerably more humane. But slaves were property and despite their unique human qualities, as property they were considered in a category apart from the rest of society. A body of law and judicial decisions grew up defining the relationship between whites and Negroes. These legal sanctions heaped upon custom constitute the principal body of race legislation in America. Among the earliest racial legislation are prohibitions of intermarriage between Negroes and whites.

In the course of the Civil War and the collapse of the legal and political support of slavery, the power, privileges, and authority of the masters were weakened. But formal emancipation did not bring either actual freedom or real equality. New laws were considered necessary to define the new relationships between the races when the old caste order collapsed. The nation's attempt to superimpose a new pattern of race relations upon the South and to force equality by law, as evidenced by the Reconstruction measures, proved unsuccessful and produced bitter reaction. Before the 14th Amendment placed limits upon the states, eight of them passed "black codes" to make the new status of the Negro coincide as nearly as possible

with the old. The "black codes" imposed restrictions upon Negroes limiting their choice of occupations and attempted to tie the former slaves to the plantation economy. They regulated labor and circumscribed the black worker's freedom of movement.

Among the legislation restricting the freedom of the Negro are the segregation laws, or "Jim Crow" laws, enacted by most of the Southern states. Under these laws the states which made any provision at all for the education of Negroes did so under the condition of the separation of the races in the schools. Similar separation was enforced in public assemblies, including churches, on common carriers, in hospitals, and in penal institutions. The Negro was further subjected to differential treatment in the courts; he was dealt with more severely under the statutes for committing certain offenses against whites, especially sexual offenses. In some jurisdictions he was excluded from juries and limited in his capacity to testify against whites. Negro suffrage, where it existed at all, rested upon unequal terms with white persons.

The 14th Amendment, which granted the Negro "equal protection of the law," was met by a negative response from the South and induced Congress to pass a series of Reconstruction acts beginning in 1867. Military governments were established in several of the Southern states and the existing governments declared illegal. The 15th Amendment, in 1869, was followed by a second series of Reconstruction acts, sometimes referred to as the "Force Bills," designed to lay a constitutional basis for the enforcement of the amendment. With the influx of carpet baggers from the North and the ascendancy of a strong Negro political organization in the South, some of the more flagrant anti-Negro measures enacted between 1865 and 1867 were repealed. Under the impact of this order imposed from without and flagrantly in conflict with custom and attitude in the Solid South, Southern whites rallied to consolidate their strength and even turned to extralegal means to regain supremacy. The Ku Klux Klan was merely the most prominent of a number of organizations that sprang up throughout the South to intimidate the Negro and to restore the dominance of Southern whites. The Democratic Party became the white man's party and managed in most of the Southern states to rewrite into the laws the repressive and discriminatory legislation which the 14th and 15th Amendments were designed to outlaw.

Among the legislation calculated to disfranchise the Negro was the so-called "grandfather clause," which limited the suffrage to those who were lineal descendants of persons who were entitled to vote at some point in time when Negroes were excluded. Since the Supreme Court declared these laws to be unconstitutional in 1915, other devices to restrict Negroes from exercising their right to vote have been resorted to, among them property requirements, the poll tax, and literacy tests which whites were allowed to circumvent but which were invoked in the case of Negroes. In addition, when other means failed, the Negroes were effectively debarred by intimidation from registration and voting.

Contemporary American Racial Policy. Both by custom and by law a Negro in the United States is today subjected to differential treatment in almost all aspects of life. Without attempting to treat all the forms and aspects of racial discrimination, it may be well to cite the principal fields in which the Negro today suffers from grossly unequal treatment.

On the political scene, the Negro in large areas of the South is still effectively debarred from the franchise. This is done not only through the poll tax, but also through his virtual exclusion from the primary by the Democratic Party, which in effect had come to regard itself, with the sanction of the courts, as a private social club. What applies to voting applies equally to the holding of public office. Even in the case of appointments under Federal Civil Service regulations, the Negro finds himself accepted only in inferior positions, and grossly under-represented, and where accepted, to a large extent segregated. This is even more true in the State governments, except in those Northern urban areas where the Negro enjoys considerable political power and hence can exact certain limited concessions from the patronage dispensers.

In the armed forces racial lines are clearly

recognized. The Negro soldier is on the whole strictly segregated into colored units. There are few Negro officers and they never command white units. Although in our earlier history Negroes had distinguished records in the United States Navy, only recently has the Negro again been eligible for our naval forces in any other capacity than as messboy, and he has not yet achieved officer rank.

Some governmental agencies on the Federal level have recognized the importance of race relations as they affect their specific activities and have appointed special personnel, such as race relations consultants, to deal with these problems. Valuable as their function has been, these race relations consultants, who are generally Negroes, are frequently put into the impossible position of having to serve as shock absorbers to protect the policy-making officials against Negro protest, while at the same time they are powerless to deal with the grievances of the Negroes arising out of unequal treatment and race discrimination.

In the awarding of war production contracts by the Federal government, in accordance with Congressional action, clauses have been written into the contracts prohibiting racial discrimination in employment. By executive order of the President a Fair Employment Practices Committee has been established to minimize discrimination against Negroes in defense industries, but unfortunately this committee has little power aside from the weapon of publicity to deal with violations.

Segregation legislation in the Southern states provides for "separate but equal accommodations" for the two races. In fact, however, separate accommodations have rarely meant equal accommodations. This "Jim Crow" legislation applies not merely to segregation in public institutions, but to private facilities as well, including places of amusement, restaurants, and even cemeteries.

Although there is ample evidence of discrimination against Negroes by legislative action, the unequal treatment of the Negro goes beyond the scope of law. Though in theory he receives the equal protection of the law, in fact he must suffer from virtual exclusion from juries, inadequate facilities for his defense, the prejudice of the police, prosecuting agencies and judges, who are generally white; and the disadvantages that come from unfavorable organs of public opinion, hostile public sentiment, and the ever present danger that if legal methods for denying him justice are not effective, mob violence will take its place.

That the Negro has suffered from unequal public services is such a commonplace fact that it hardly needs mentioning. A notable exception is the equitable treatment of the Negro under the Federal relief program during the depression, and under the provisions of the Social Security Act, save as in practice state and local administrators of these measures have been able to nullify the intent of the Federal government to avoid discrimination in relief and welfare measures. There is overwhelming evidence to show, however, that not merely in the South but in the North as well, the Negro has received inferior police protection, sanitary facilities, medical care, housing, recreation, and education.

It is particularly in the field of education that racial discrimination has been most widespread and has reacted most unfavorably upon the long-term prospects of attaining equality of opportunity for the Negro. It happens that the Southern states which segregate the Negro in the schools are also the poorest states and would be able to furnish only mediocre educational opportunities even if they had to maintain only a single school system. A dual school system, however, imposes increased financial burdens upon these economically disadvantaged areas and generally results in grossly inferior school facilities and educational opportunities for Negroes. This tends to perpetuate the already existing inequalities by depriving the Negro of opportunities to rise in the economic and social scale.

There is a long history in the United States of attempts to impose residential segregation upon the Negro by law and local ordinances. Recent Supreme Court decisions, however, have undermined the constitutionality of these acts, and, in the absence of suitable legal devices, property owners have resorted to private arrangements between themselves known as "restrictive covenants" which debar Negroes almost as effectively from free

choice of residence as if the segregation were enforced by law. As yet there is no definitive decision by the Supreme Court invalidating such private contracts on the ground that they are contrary to public policy.

Even where the Negro is not subject to discriminatory treatment by law he is nevertheless severely handicapped by custom and public policy. This is manifested in the singularly consistent imposition of unequal standards of merit and recognition accorded to the Negro in the professions. Even Northern institutions relatively free from public pressure, such as higher institutions of learning and professional associations, only rarely admit Negroes and offer them opportunities to make their contributions on equal terms with whites. With the possible exception of the arts, the Negro is thus made dependent upon the more limited rewards and recognition that he can derive from his own circumscribed racial group. If it is recognized that success in almost all fields of human endeavor depends not merely upon native capacity but also upon opportunity, hope of reward, and traditions of success, it can be inferred how severe a handicap is imposed upon even those Negroes who have superior talents. Under these circumstances it is no wonder that the economic, political, and cultural advancement of the Negro has been slow. Indeed the Negro has remarkable achievements to his credit in the face of these severe, chronic, and cumulative handicaps.

Discouraging as the prospect of attaining more nearly equal opportunities for persons irrespective of race might seem to be in this country, there are, nevertheless, some signs of a greater awareness of the problems involved and of a willingness on the part of the dominant white group, even in the South, to make concessions to the rising tide of democratic sentiment and enlightenment. Aside from Federal legislation and administrative policies already referred to above, the Negro's quest for equality of opportunity has been immensely strengthened in recent years by a number of Supreme Court decisions. Among these has been the reaffirmation on April 28, 1941, by unanimous decision of the Supreme Court, that Negroes traveling from one state to another are entitled to railroad accommodations equal to those furnished white persons, which while it does not specifically do away with segregation will compel interstate carriers to provide the same accommodations for Negroes and whites who buy first-class tickets. Another decision of May 26, 1941, held that Congress has the power to regulate primary elections in the same manner in which it regulates general elections, a decision which, while subject to greatly varying interpretation, may undermine the Democratic primary system of the South, which has debarred the Negro from the franchise. Of special interest are recent court decisions making it mandatory for states which exclude Negroes from higher educational institutions and professional schools to provide such education of approximately equal quality. A series of decisions in peonage cases and reversals of lower courts' decisions in criminal cases involving Negroes, on the ground that Negroes were excluded from juries and that the defendants did not receive fair trials because of their race, has served as a warning to local jurisdictions that the Federal constitutional provisions establishing equal protection of the law irrespective of race can no longer be so easily evaded. The public discussion that has resulted from the introduction of anti-poll tax and anti-lynching bills may be regarded as a further sign that the nation as a whole is concerned about the nullification of the fundamental laws by certain states and localities where these laws run counter to the racial mores.

The bold and outspoken statements of leading personalities and of organizations—including many in the South—in denunciation of racial discrimination are a further sign of impending changes. The development of the CIO as a new labor organization more nearly free from the established prejudices of the older existing labor groups also augurs well for the enhanced employment opportunities of the Negro on a basis more nearly equal to that of whites. This trend is strengthened by recent opinions rendered by the Attorney General holding that contracts between employers and unions discriminating against Negroes are invalid. The passage of more stringent civil rights legislation in such states as New York and Illinois, which recently have received large influxes of Negro mi-

grants, is another wholesome step. These laws provide severe penalties for deprivation of equal civil rights including equal accommodations in private commercial establishments. They provide further for punishment and damages for mob violence. They reaffirm the right of equal access to employment opportunities. The New York law forbids discrimination by life insurance companies on account of race. These steps are further indications of growing public awareness of the danger inherent in the spread of racial discrimination from the South to other parts of the country. They suggest a slowly emerging public policy designed to attack discriminatory racial practices generally.

War Experiences and Post-War Prospects. There seems little doubt that this recently accentuated awareness of the discrepancy between our national ideals and our actual practices and policies in relation to race is connected with the character of, and our involvement in, World War II. In a very real sense our enemies have thrust the race issue upon us. They have attempted to make this into a racial war, and the important question for America, therefore, is whether the Nazi doctrine of race and the practices that go with it shall make progress in this country and shall be allowed to divide us, to undermine our national solidarity, and to frustrate the exertion of our maximum potential war effort.

At first glance it would seem that in a country as diverse in its racial and cultural composition as ours, the propaganda of racism would have little prospect of succeeding and the practices of our enemy in respect to what they call inferior races would arouse universal horror and disgust. But we cannot talk out of existence the racial, religious, and cultural conflicts and prejudices which have flourished among us and which have given rise to organized movements of Nativism, Know-Nothingism, Ku Kluxism, and other movements of intolerance and bigotry. Our enemies have demonstrated the power of propaganda which can thrive upon latent attitudes of race antagonism and race mythologies, especially in times of crisis and under conditions of personal insecurity. We must expect our enemies to exploit the resentment that racial minorities feel against the restrictions of their constitutional rights to vote, to enjoy the privileges of citizenship, and to receive equal treatment under the law; against discrimination in employment and in public conveyances; against deliberate segregation; against unequal educational opportunities; against the blocking of their paths of personal advancement; and against not infrequent mass violence.

Unfortunately, the stark necessities of war, while they have made us more conscious of the promises of democracy, have also frustrated our ability to fulfill them. Indeed, we have resorted, perhaps unnecessarily, to measures which have widened old and generated new forms of racial discrimination. We have, for instance, indiscriminately herded Japanese residents, irrespective of their citizenship, into relocation centers and thus nullified the dignity of American citizenship and subordinated it to the criterion of race. We have deprived a substantial part of our citizenry, solely on account of race, of the privilege of contributing its full measure of strength to the winning of the war.

Among the bulwarks upon which we rely to protect us from being engulfed by racial prejudices are those found in the Preamble to the Declaration of Independence, in our Constitution, and in the Bill of Rights. There are few peoples in the world who have affirmed as high a set of principles as these to guide their public policy. Far as we have been from actually realizing the ideals expressed in these noble state documents, they do nevertheless constantly remind us that as a nation we cherish the principle of the equality of men before the law and equality of opportunity for all. We know that not all men are born equal and certainly not all are treated as equals, but we have set equality down as a goal toward which to strive and as the criterion for determining the soundness of public policy. We are at least sure of the direction in which we want to move as a nation.

Race relations policies for any nation are no longer a matter of purely domestic concern. They are issues that concern the world as a whole and they will inevitably be an important phase of the task of post-war world

reconstruction. All the caste-like arrangements subordinating the colored races to the white group are rapidly crumbling under the impact of the inevitable and increasing contacts between peoples generated by the spread of urban industrial civilization. The ideals of freedom and human equality embedded in the religious and political heritage of occidental society, which were given new impetus by the American, French, and Russian revolutions, have continued to fire suppressed peoples everywhere with the ambition to improve their status. The protest against exploitation and subordination of one racial group by another has become world-wide. It has awakened the conscience of the dominant groups in all parts of the world to the indefensibility of their exclusive prerogatives based upon race. In the course of the struggle against fascism and its accompanying dogma of racism, the democratic ideology has acquired new vitality. The value of racial equality has acquired such political force in the world that even such nations as Japan in the course of the war have found it advantageous to grant at least nominal freedom to some of their conquered territories in order to make our own promises of freedom to these peoples seem hollow and hypocritical.

Fortunately, our record in the period immediately preceding the World War offers ample demonstration of the fact that we did not need the impelling motive of military expediency to adopt a more enlightened racial policy. Our action toward the Philippines, for instance, lends strength to the belief that we can resist the temptation to impose ourselves as imperial masters over other peoples and that we can win their loyalty and friendship through improving their lot to the best of our ability. Our recent efforts to improve the conditions of life of the people of Puerto Rico, coupled with the suggestion by a responsible official that they be given the right to elect their own governor, offer similar testimony of our decent intentions. Our relinquishment of extra-territorial rights in China and Congressional action eliminating Chinese exclusion, though beclouded by the fact that these actions were taken under the pressure of war, constitute other proof.

In our own country we have been making strenuous efforts through a more enlightened policy toward the Indian to make good the injustices which were done him. In the case of the Negro, the virtual disappearance of lynchings, the improvement in education, health, housing, and welfare, the resolute steps toward actual enfranchisement, the improvement in the administration of justice, and the provision through official and unofficial action of greater employment opportunities are other encouraging signs that have received widespread public support. What is most important of all is that for all minorities we have shown increasing concern to keep the door of opportunity open.

While we are far from having eliminated distinctions in law, custom, conventions, social usages, ritual, and etiquette based solely upon differences in race, we are in our public policy definitely moving in that direction at a faster pace than we have ever done before. It must be recognized, however, that public policy is shaped by the citizenry and that official action cannot in the long run be either too far ahead or too far behind public sentiment and opinion. The public sentiment and opinion that will ultimately shape both public policy and private conduct is becoming more world-wide in scope. America for centuries has been the experimental proving ground for the principle that men irrespective of their race, creed, or origin can live and work together harmoniously for the common good. If we as a nation can keep alive the struggle for the fuller realization of the ideals which we have as yet only imperfectly achieved, we shall gain an immense source of strength against the enemy and we shall have a more certain prospect for building a better world for all mankind.

MENTAL DECLINE AND ITS RETARDATION

By GEORGE LAWTON

We all want to maintain until death the physical, social, and mental effectiveness of early and middle maturity. Anyone who could find a way of permanently arresting decline in any area of human activity, would be discovering a fountain of youth; but I do not report any such discovery.

Throughout human history both physical and mental rejuvenation have been sought through physiological agencies, and this is the main trend even today. However, we must investigate the extent to which we can reverse and retard mental decline solely through psychological techniques. This is a problem which respectable psychologists seldom consider, for it is not easy to free the topic from its association with magic and charlatanry.

I

Intelligence, that entity measured by intelligence tests, matures between the ages of thirteen and sixteen, and stays on a level until the early twenties. Though we gain mental stature quickly, we lose it slowly; for the gain in ability of the last three years of mental age growth (13 to 16) is gradually lost in the next sixty years, with the larger portion of the decrements coming in the forties and sixties. By the age of fifty-five we have receded to the fourteen-year-old level.

However, if we separate the different abilities involved in the total functioning called *intelligence,* we find that each ability has its own rate of decline and its own degree of susceptibility to remedial measures. Peak levels in physiological functions are reached earlier than in psychological ones. Hence, the more a mental activity includes a physiological factor, the more it declines with age.

In what follows, mental abilities will be spread out in a kind of spectrum, starting with those mental abilities most dependent on physiological function, and ending up with those least so.

Vision and Hearing. These functions—non-mental but a necessary foundation for mental ones—reach their peak in our late teens and decline slowly. At the age of fifty, there is normally a degree of hearing impairment for higher tones sufficient to affect ordinary conversation. Visual efficiency at the age of sixty is ten to twenty percent less than at forty.

Reaction Time. This is a combination of speed of perception, involving the senses of sight and hearing, and the rapidity of muscular function. It reaches a peak in the late teens or early twenties. Of all the mental abilities, it is the most dependent on physiological function and therefore shows the most marked loss.

Life gives tests of reaction time when psychologists do not. In automobile accidents involving pedestrians, two thirds of those killed are over forty. However, in an experiment of W. R. Miles, twenty-five percent of the seventy-year-olds had a reaction time equal to the average of the group, the latter covering the entire age range.

Immediate Memory. Although this ability reaches its peak in the late teens and early twenties, it declines rapidly with age. Forgetting recent events is one of the classic indices of senescence.

New Learning. The work of Thorndike, Miles, and others has shown that the ability to learn new things reaches its maximum in the late teens and early twenties and then starts slowly declining.

Jeanne G. Gilbert in a study of sixty-year-olds also reports that the type of learning in which loss is greatest is that of "paired associates." The more a task differs from an already existing habit pattern, the greater the loss in ability with age. However, immediate reproductive ability, such as making simple repetitions, shows relatively slight loss.

Old Learning. If vocabulary is taken as an example, old learning declines little or not at all with age, first, because as earliest formed material it is not much affected by physiological decline. Second, it is learning that is constantly exercised.

Judgment and Reasoning Ability. This

develops slowly in general or in a given area, reaches its peak latest of all abilities, and is among the last to go.

The strategy of tackling problems often improves with age. Harry De Silva, an authority in the driver testing field, observes:

> Although this decline in reactive time is important and should be recognized and allowed for by persons as they grow older, it has too often been exaggerated. The older person's improved judgment, better emotional control and coolness in the face of emergencies, usually more than offset the slight loss of sensory capacity and motor control. In tests of adaptability and vigilance, older experienced drivers invariably rank higher than young ones.

In driving accidents, it is the young age groups that are mostly involved. In industry, the carefulness, good judgment, and experience of the older worker lead to a lower accident rate. We must note Pressey's caution, however, that in any factory there is a continual weeding out of the unfit.

Creative Imagination. This apparently undergoes little or no decline. Through the use of the Kinephantom—a revolving fan whose silhouette appears like an animated ink blot—W. R. Miles found that younger and older individuals in an average population achieved practically the same scores.

Creative thinking has been studied by Harvey C. Lehman. For several kinds, such as in philosophy and medicine, the peak levels of achievement are at the age of thirty-five to thirty-nine. In music, some composers reach their height between thirty-five and thirty-nine, others reach theirs between forty and forty-four. Military leaders and authors of best books also reach their peaks between forty and forty-four. But the top of the political ladder is most likely to be reached by men who are between fifty and fifty-nine. While Lehman would place the peak of human physical strength and skill at about twenty-seven to twenty-eight, leadership in business and in politics is achieved thirty years later.

Where the unique creative product depends largely on physiological activity, greater achievement will come earlier; when it is more dependent on psychological factors, it tends to appear later. Dorland shows that the average age at which the masterpiece was produced runs as follows: physicists, forty-one; inventors, poets, dramatists, and playwrights, forty-four; novelists, forty-six; explorers and warriors, forty-seven; actors and musical composers, forty-eight; artists and divines, fifty; reformers and essayists, fifty-one; physicians, surgeons, and statesmen, fifty-two; philosophers, fifty-four; astronomers and mathematicians, satirists, and humorists, fifty-six; historians, fifty-seven; jurists and naturalists, fifty-eight.

It is Lehman's view that individuals may make invaluable creative contributions at practically every chronological age level beyond early youth. Woodworth also states: "Another condition favorable to invention is youth, with its openness to new impressions and its radical tendency to do something different from what has been done before. But maturity also is necessary for socially important creative work. . . . It would be foolish to draw a dead-line anywhere."

II

Few people live long enough to undergo severe obsolescence of *all* abilities and functions. We therefore should speak not of an aged person, but of an aged ability, function, or adjustment, whether it be physical, mental, emotional, social, or vocational.

However, as long as we include speed factors in our appraisal technique we will discover a difference in efficiency between a group of persons in the sixties and one in the twenties. Miles found that by the age of seventy there will be an average decrement in strength, skill, and sensory acuity of one fourth to one third from the twenty-five-year-old average.

If we eliminate speed and consider only mental power, however, the difference between older and younger individuals is reduced. Intellectual persistence—a non-speed factor—does not show age decrement. Even with regard to mental efficiency, individual differences may be as great at the older ages as at the younger. In most types of work, the decrease should not be important and might well be more than balanced by greater experience and dependability. As Pressey says, "To the average person, it is of little practical importance that he can not run as fast at sixty as he can at thirty;

at all ages, the usual pace in self-locomotion is the walk."

Only a small number of individuals in the sixties under present educational and vocational conditions are capable of attacking with normal efficiency (i.e., as speedily) tasks involving new learning suited to their native intellect. Nevertheless, age alone is not a sufficient factor by which to judge efficiency in any particular work, since judgment, better integration of knowledge, and practice over a long period of years will compensate for losses in motor dexterity and sensory acuity. The older individual retains almost unimpaired his capacity for solving *mental* problems of difficulty equal to those he could solve when younger.

Older men generally are not suitable for pursuits that require long periods of sustained physical activity, exposure to danger of bodily harm, dexterity of the hand, or ability of the limbs. But when we need a thoughtful application to a particular task, older workers can serve as well as, or better than, younger ones. The indiscriminate shelving of men and women merely for age inflicts a loss upon society and the individual. If we shift workers from those jobs involving speed and strength to those involving skills which decline slowly with age, we can continue to utilize in industry many older men and women. Any defense plant today can provide examples of this. Let us hope the lesson will not be forgotten when the war ends.

III

The first to show that we can retard and even reverse mental decline was Dr. Lillien J. Martin, who at the age of sixty-five started the San Francisco Old Age Counselling Center. Until her death at ninety-two on March 26, 1943, she was still actively engaged in her consulting work with aged clients. The writer is fortunate to have concluded a period of study with her only two weeks before her death and to have had access to her case records.

Existing proof that mental decline can be retarded is clinical rather than experimental and is to be found mostly in Dr. Martin's records. For her clients she devised a suitable psycho-educational remedial exercise for each mental ability that showed deterioration and for which the prognosis of reversing decline seemed good. For each pattern of living that handicapped the old person in his relationship to people or his job, Dr. Martin tried to point a way by means of which the client could achieve a new and better pattern. The criterion for success at the Old Age Center has been a pragmatic one; for example, the individual got a new job, or did better on the old one, or established more pleasant and effective relationships with members of his family.

My own readjustment work with the aged has convinced me that retardation and reversal of decline is possible. I find that least amenable to psychological techniques are those abilities with a large physiological component; most amenable are those that are largely mental.

However, psychologists doing rehabilitory work with older people find that even physiological deficits can be outwitted through suitable strategies or compensations. Every deficiency has two aspects, one the deficiency itself; the other the way it is used. Which will it be: to overcome or to be overcome by the effect of one's losses? The attitude toward the declines shown by the individual involved and by society act and react on each other. If the individual disregards the changes that can be disregarded and develops substitute physical facilities or patterns of behavior for those changes that cannot be ignored, the world is more likely to accept the aged individual at his own valuation; the converse is also true.

Pressey points out that world records in most sports continue to be broken. Some of this improvement is due to the better methods of training. A number of athletes, moreover, have had to overcome physical handicaps in order to achieve championship distinction. If effort, practice, and ingenuity can bring about such gains in sports, there are unsuspected potentialities in almost everyone. An older person determined to utilize his resources to the maximum might raise his level of fitness to a degree now thought impossible.

Physiological changes are largely responsible for the inability to make fresh mental associations. Old people talk more about the past partly because it has been better re-

corded, but also because their younger days are more emotionally toned, more tied up with a period of life in which hopes and desire for achievement and activity were at a maximum, and were either dramatically gratified or frustrated. Youth, finally, is a time when most persons have more emotional security and warm parental love than ever after. An older person who in the present has an opportunity to function and in it receives love and approval, does not need the past as a crutch. He will remember events in the present because he belongs to it and it belongs to him. Psychotherapy possesses great power to unhinge the old person's overdependence on his past.

While there is a decrease in the amount of learning which persons acquire as they grow older, there are minds which, because of great inner incentives, are able to amass knowledge until the most advanced ages. But even ordinary persons, as shown by Thorndike, Miles, and others, have far more ability and learning capacity than they ever utilize.

Some of the decreased physiological receptivity to new learning can be compensated for if an old person is compelled to be interested in it, as under wartime stress. The older person often pretends to be impervious to the world about him because he regards it as a threat. Many a senescent exaggerates his sensory loss in order to escape or to punish a world he believes does not like or understand him, a condition often caused by the fact that he has allowed it to grow unfamiliar, and unfamiliarity, as we know, breeds contempt.

If we reject people vocationally in middle maturity, and give them no opportunity or reason for learning, we cannot be surprised by the results in late maturity. The older men and women working in war industries or engaged in civilian defense have demonstrated a usefulness that except for the war might never have been realized, either by the community or by themselves.

IV

Part of the ostensible mental loss of older persons is simply the piling up of poor work habits; a job or life situation is of a treadmill type. If activity is essential to the preservation of mental ability, this is an additional reason why retirement is unadvisable for many older people, and why every union and every professional organization should have a department which will plan for retirement *to*, not retirement *from*. People should be retired not on a particular day, but over a period of years by means of a stepping-down and retraining process, and through the medium of a job reallocation bureau, operating within the industry or profession itself. Someday every community may have its schools for older people with courses of study designed for the special needs, interests, and abilities of men and women in the sixties, seventies, and even eighties, and with vocational guidance counselors doing a tailor-made guidance job for individual old people.

Ultimately we also shall have to develop a whole repertoire of ways to utilize the judgment and experience of older people, whether these be in an advisory and teaching capacity, in the field of family and home relations, in industry, or in some work of an educational, social service, or recreational character. Advisory functions might be exercised within the family, but since the generations in our culture are not always amicably disposed toward one another, a clearing house by means of which an older individual might find young people to guide would help keep his interest alive and his mind active. Instead of pitting age against youth, we should strive to realize the potentialities of each. Cooperation, rather than competition, will bring out the best in each age grouping.

A good emotional adjustment is essential to continued utilization of whatever mental efficiency one possesses. Many factors which are unrelated to age or to intellectual decline as such, may lead to a pseudo-senescence. Some of these are: family dissensions; feeling of inadequacy; pressure, real or imaginary, from a superior or from youthful competition; money difficulties; an insecure job; unemployment. It is fear of aging, rather than the aging process itself, which often causes a functional loss in the mental realm.

We cannot dissociate intelligence from such other factors as motivation to learn, pressure to utilize fully what has been learned, and environmental opportunity. As Lehman points out, how can we motivate the

older individual as well as the younger one if the oldster has attained many of his life goals or if at some arbitrary age he is compelled to stop having goals? Does our civilization offer the older adult the same intellectual diet and opportunity to learn as it does the younger adult?

It may be that some old people are either unable or unwilling to assimilate much new experience. But before we accept this as a psychological law we must discover how much new experience our culture makes available for them. Our society does make a slight attempt to meet the custodial, economic, and medical needs of older people. In peacetime, however, we make no attempt to provide for their mental stimulation and thus contribute to the preservation of intellectual abilities.

The best solution is to have at presenescent age levels continuous adult education, and recreational, vocational, and personal guidance. A program providing for the individual's time during the post-employment period should be drawn up by management and worker while the latter still is employed. The old person who, while not physically incapacitated, wants to spend all his time "resting," is a neurotic now grown old. This he does either because of past failures, fear of future ones, or because he feels his efforts will be inadequately rewarded. The rocking chair type of senescent needs either vocational guidance, psychotherapy, or both. What he gets today is a better rocker.

The ideal situation for preserving mental abilities is one where an old person is provided with moderate economic security and medical care, but where he is constantly being compelled to face and solve problems that tax him to his mental limits though not beyond. Retirement allowances, medical care, institutions, homes—these no more meet the total mental, emotional, and social needs of older people than the same facilities would meet the needs of children.

Best for old people would be real jobs, real family relationships, real and challenging tasks in a civilization that needs them and wants them. But if men and women over sixty cannot be given lives that are real, they must have them by proxy. The aged need schools, recreation centers, arts and crafts centers, sheltered work shops, adult playgrounds, marriage brokers, social clubs. They need bureaus for the exchange of services. They need to adopt, spiritually, young people and whole families; they need volunteer and part-time jobs. Recreational and creative activity, personal fulfillment, edution, drawing from society and contributing to society—none of these, no matter how achieved, need ever end.

The late Earl Balfour, as he lay dying, whispered: "This is going to be a great experience." To meet every changing vista or circumstance in terms of its power, not for hurt, but for enlightenment or stimulation, is to be prepared for waning physical powers, loneliness, misfortune, or mental decline.

THE SCHOLAR AS TEACHER

By RALPH F. SHANER

AWAY back in 1913, when I took up Biology at Lafayette College, I underwent an unforgetable experience. Professor Alvin Davison did not teach as other men do; he led us to teach ourselves. He divided the substance of each course into topics which he assigned to the students in turn. For example, he assigned me the teeth of the cat. In the laboratory stood a small box of ordinary index cards. On one of these I found a few general directions and references. With no other guidance, I bent over specimens and books for a week. On the appointed day I was the professor for fifteen minutes. I demonstrated my specimens with the aid of blackboard drawings, self-made charts, and any other device I could think of. Each of the students of the class presented a similar report in rotation throughout the two years of the course.

I doubt whether Professor Davison gave a half dozen formal lectures. One was a substitute for a final examination. We had no tests or final examinations. Attendance at the laboratory was not checked. The students might be anywhere collecting material or making field tests. Microscopes, books, and reagents stood on their shelves to be taken down at will. The door of the building was never locked. It was a common sight to see a lone student busy late at night changing reagents or transferring cultures.

Biology was not an easy course. The industry of the "cat lab" was proverbial. The professor seemed busy with his own affairs, but he knew all that happened. The slacker was reproved, and the puzzled worker was given timely help. We students did the rest.

The reader will recognize the similarity of Davison's method to the innovations of ultra-modern progressive educationalists. Davison never claimed any originality; he remarked once that he had been brought up in it by his own teacher. The method was not new with his teacher, either. On the contrary, it has a history of some length and significance to American higher education.

For its origin one must go back to Ignaz Döllinger (1770–1841), Professor of Anatomy at Würzburg and Munich. A man of extraordinary scholarship and technical proficiency, Döllinger is remembered chiefly for his pupils. His own son was the celebrated theologian who suffered excommunication for leading the opposition to the adoption of the doctrine of Papal Infallibility. His sons in spirit were Purkinje, Pander, Martius, von Baer, and Agassiz, every one a great man in the natural science of the first half of the nineteenth century.

Döllinger's method of teaching is described by his most famous pupil, Karl von Baer, the founder of the science of embryology. Von Baer was educated as a physician at Dorpat in his native Esthonia. His medical course was interrupted in 1812 while he served as medical officer to the German contingent of Napoleon's army on its march into Russia. The horrors of the campaign turned von Baer from medicine to natural science. Someone suggested that he apply to Döllinger at Würzburg.

Taking a parcel of mosses as an introduction, he presented himself to Döllinger:

> I gave him the package of mosses from Martius and explained that I wished to study comparative anatomy under him. "I do not lecture on comparative anatomy this semester," replied Döllinger as he opened the package with his characteristic calmness and deliberation and began to look them over. I was thunderstruck. Döllinger looked over the mosses a while, and then noting that I still stood there, turned and looked me over a bit, and continued with his same deliberateness, "But why lectures? Bring some animal, any animal, and dissect it here, and after that something else."

Casting about for material, von Baer happened upon a leech at an apothecary shop. Döllinger gave him a few directions and then left him to his own devices. The first dissection was a crude affair. Döllinger then brought him Spix's monograph on the leech to show him how the dissection should be done, and directed him to repeat the work. In this manner von Baer progressed from animal to animal. At each step Döllinger

lent him some standard monograph, gave a little advice, and then left von Baer to work things out himself. In the same casual way Döllinger led von Baer into the new science of embryology and started him on his life work.

Von Baer was what would now be called a graduate student, but much the same system of teaching prevailed in the undergraduate course in anatomy at Würzburg. Dr. Hesselbach, the junior professor, carried the method to extremes. Beyond preparing a model dissection, he refused to give any directions. When asked for advice he only pointed out to the student the part that should be dissected further. He behaved as if he were dumb.

When von Baer came to teach anatomy at Königsberg, he introduced the modern lecture-laboratory method of instruction. His opinions on teaching methods are worth reading:

> As a rule a lecture provides little more than a stimulus for the listener. Real fruits come only from self-application. If the lecture attempts to give facts to be stored in the memory, whether by pictures or by words, they do not sink in very deeply at the time and certainly are more quickly forgotten than when one takes pains to imprint them, and learns them by lingering over them long enough to become thoroughly familiar with them.
>
> The student working by himself will need very much some judicious guidance in general theoretical concepts and in the making of observations, and the guidance must be that of an experienced and discerning man who is completely at home in the subject. I do not consider the Professor superfluous, after having been one myself so many years. I do think, however, that he should aim more to teach the students to teach themselves than has hitherto been the practice in some courses.
>
> Instead of demonstrations by the instructor (which I consider only harmful), I had the student demonstrate his finished preparation to me. I gave the student help only when he showed that he had tried to find his own way. Every student should have his text beside him.

The writings of von Baer exercised great influence upon Huxley. Huxley introduced von Baer's methods into his teacher training class about 1870, and thereby started a revolution in science teaching in England. One of Huxley's demonstrators was H. N. Martin, who later came to Johns Hopkins and carried the method to America.

Shortly afterward, F. P. Mall became the first Professor of Anatomy at Johns Hopkins. Mall was also a great admirer of von Baer. Mall reverted to Döllinger's original plan and dispensed with lectures almost altogether. The reaction of the students is described by Gregg:

> Just after that conversation I saw in the street a student I had known when we were together at a boys' camp. I taxed him for information about Hopkins. ''Oh it's wonderful,'' he said, ''and what teachers,—Welch, Howell, Abel, . . . all except one.'' ''Is that so,'' I replied, ''and who is he?'' ''Oh his name is Mall. Do you know what he did the very first day in Anatomy? He said, 'Gentlemen, the dissecting rooms are open from nine in the morning till ten at night. I can recommend the three following textbooks. There will always be some one there to help you if you get stuck, and when you are ready to take the examination, let us know.' Now if you can beat that for a ——— of laziness you're going some.''

Mall began his work at Hopkins in 1893. The storm he raised in medical education still rages.

The spirit of Döllinger came to America even more directly through Louis Agassiz. Agassiz lived with Döllinger in his later Munich days and, like von Baer, acquired a lifelong interest in embryology and in original ways of teaching. Agassiz, as Professor at Harvard from 1847 onward, exerted a powerful influence in college science departments of his time. His way of dealing with students is illustrated by the following anecdote of President Eliot:

> William Sturgis Bigelow, son of the eminent surgeon, Henry J. Bigelow, went through the medical school between 1871 and 1874, but at graduation was not sure that he wished to be a doctor or a surgeon. One day he said to his father: ''I want to study some more natural history before I decide to be a practicing physician. I want to go to Professor Agassiz's laboratory and study under him.'' His father thought the son's scheme was foolish, but that he had better try it. On the first day Agassiz gave him a trilobite and said to him: ''Look carefully at this trilobite and describe in this notebook everything you can see on this fossil.'' He said nothing more; and young Bigelow worked all morning on these directions. In the afternoon Agassiz appeared again at Bigelow's desk and remarked: ''That's pretty good so far; but you haven't finished by any means. Go right on.'' Young Bigelow put in all the afternoon. The next morning Agassiz came in again and remarked: ''Bigelow, you are getting on. Keep right at it.''

Agassiz was a research man of very first rank, a profound scholar, and gifted lecturer. He trained a whole generation of American

teachers of natural science. He was in all likelihood the source of the teaching methods used by Davison at Lafayette.

It appears then, that some modern trends in education have a quite respectable history, and one long enough to afford a basis for evaluating some present-day proposals.

There is little question that students in general college courses would benefit from fewer lectures and more self-study. One who has not passed through such a course as we had at Lafayette cannot appreciate the mental exhilaration and abiding interest in scholarship that we acquired. What we taught ourselves, we learned forever. What the other students taught us may have faded, but we know how to get it back again. No finer training for life or for later teaching can be conceived.

But for technical and professional students the case is otherwise. Life is too short, the amount of exact information needed is too great, and the significance of much of it too remote. A skillful lecturer is needed to guide the student through the maze of detail, to put first facts first, and to supply a temporary sustaining interest, that the student may hold his knowledge until experience provides a permanent interest. Much must be learned by rote. Why apologize for rote learning? Man and animals learn the fundamentals of daily living by rote, and understand why things are done so afterwards. It is the only practical way to learn many things.

Students and circumstances vary, but one thing is always needful: a teacher who is *ein erfahrener und umsichtiger Mann der in der betreffenden Disciplin vollkommen orientirt ist.* There is no substitute for critical scholarship and common sense. Research ability is a noble attribute of any teacher, but the glamor of published papers must not blind us to the truth that original investigation benefits the teacher and his students only in so far as it enriches and refines his critical scholarship. The savant deserves more recognition than he is accorded in our colleges and universities.

What shall we say of the teacher who deals out the dregs of old subjects in neat new packages, attractively labeled, and who knows as much of what he teaches as the salesman does of the goods he sells over the counter? The salesman as teacher is a new phenomenon. He may impress business men, but hardly their children, unless students are different from what they used to be.

SCIENCE ON THE MARCH

PLANT BREEDING BY INCUBATOR METHODS

Not unlike the famed Caesarean section and the incubation of immature animal embryos is the technique employed in plant breeding whereby the embryo is dissected from the mother fruit during the growing season and placed in an "incubator" under aseptic conditions, properly nourished with various salts and a sugar supply, with the result that a new individual is produced—an individual which might otherwise have perished.

An illustration of its usefulness is provided by the plant breeder working with the stone fruits—the peach, cherry, plum, and apricot—and who is breeding for early-ripening varieties of these fruits. When crosses are made in which a very early-ripening variety is used as the female parent, a high proportion of abortive embryos are produced. In fact, no viable embryos have ever been secured from crosses involving certain varieties as female parents. To be sure, a fruit may be produced in the crossing, but when the pits are planted no seedlings develop.

In nature, accordingly, evolution is blocked in the direction of breeding for still earlier-ripening varieties of these fruits. Both the fruit grower and the housewife will attest to the greater natural abundance of late-ripening varieties than early-ripening sorts. Late-ripening varieties tend to reproduce other late-ripening sorts, but the early-ripening varieties tend to eliminate themselves by their failure to produce viable seed. But, by the employment of the incubator technique, it is possible to breed in the direction of varieties ripening still earlier: it becomes practicable to use early-ripening varieties for both parents, to cut the resulting embryo from the mother fruit during the growing season before the embryo has disintegrated, to culture it by incubator methods, and to develop fruiting trees which may be the forerunners of new varieties ripening even earlier.

The technique in detail calls for the use of some suitable incubating chamber, such as a $\frac{1}{2}$-ounce glass bottle with metal screw cap, which must be both sterile and clean so as to be free from any possible source of contamination. Into the bottles is placed a nutrient solution containing certain essential salts and a source of carbohydrate, such as glucose, plus an agar gel as a surface upon which to grow the plant, since the embryo does not develop when submerged. A $\frac{2}{3}$-percent agar gel has been found sufficiently stiff to support the embryo on the surface, and yet sufficiently soft to permit easy penetration of roots and easy withdrawal of moisture and nutrients for growth and development.

The fruit is brought into the laboratory during the growing season at about the stage when by examination it has been found that the embryo is checked or aborted. The fruit is washed and carefully opened, exposing the seed. The seed itself is then carefully dissected so as to remove the seed coats and other enclosing tissues, and the naked embryos are removed and placed in the sterile incubator bottles.

Two methods have been used; namely, one employing a disinfectant of 2 percent chlorine solution and another in which no disinfectant is used. While in the early years of study a disinfectant was found essential to free the culture from contamination, later developments have made it possible to remove the embryo under aseptic conditions without the use of a disinfectant. Growth is similar by both methods, the latter being superior for young embryos and for delicate tissues.

After a few weeks in the incubator bottles, and when the embryos have developed sufficient shoot and root to support the young plant, the new individuals may be shaken from the bottle and transplanted to sterile sand supplied with a nutrient solution. When the plant has reached sufficient size in the sand, it may be transferred to soil, and finally placed in the open field for development as a tree. Peach, cherry, plum, and apricot embryos grown by this method have developed into vigorous trees which have borne fruit. In fact, so successful has the method been that one large nursery firm in

California employs a plant breeder to use it in order to develop varieties of peaches needed by Southern California horticulture.

But this is only one specific instance. There are others. For example, crosses between different species of plants are often unsuccessful owing to failure to develop viable seed—an obstacle frequently traced to physiological upsets and early abortion of seed and embryos. In such situations the embryo culture technique has been applied most successfully. For example, species crosses between different taxonomic sections of Prunus have given 72.5 percent germination by embryo culture methods and only 4.8 percent germination without such aid. Still further, 26 out of 62 attempted subgenera crosses of Prunus—still more distantly separated then sections of Prunus—have been made successfully by embryo culture, as compared with only 3 out of 304 without surgical assistance. The lily, too, has responded well; 15 species crosses have been made which have heretofore been listed as failing to produce viable seed. In the same manner many genetically possible but hitherto unobtainable crosses have been realized.

In all the successes so far reported with non-viable or abortive embryos it appears that the growth of the embryo is normal up to the time that a check occurs in its development, and that this checking is often associated with an interruption in the food supply and is a starvation effect. Accordingly, if an external source of food is provided under conditions favorable for growth, normal development continues.

So optimistic a picture requires considerable qualification. There are many instances in which embryos have failed to develop normally in culture. When embryos of some plants have been excised from the fruit fairly early in development, they have remained in a living and yet arrested stage for months under the conditions provided. In other instances they have developed curious growth patterns, characteristic of the age of the embryo when removed from the fruit, but not at all typical of the plant from which they were excised.

Much progress is being made in improved conditions of culture and in nutrients provided. For example, coconut milk has been found favorable for embryos of the Jimson weed, and young pine embryos have responded to heteroauxin and thiamin. Experiments so far made indicate some degree of usefulness of embryo culture for breeding the following plants: tobacco, tomato, radish, Jimson weed, cotton, lily, violet, gingko, pine, cherry, apple, pear, peach, plum, apricot, rose, and olive.

Quite aside from its value in growing embryos which are otherwise non-viable, the embryo culture method has been useful in speeding up the breeding program with certain plants whose embryos normally do not germinate as soon as they mature. For example, the seed of the rose and of many tree fruits must be after-ripened at a temperature of about 41 degrees Fahrenheit under moist conditions for a period of 6 to 16 weeks, depending upon the plant. Such seed does not start to germinate until the second season after the cross has been made. But by the embryo culture technique it is possible to germinate embryos even before they have become fully mature and thus to speed the number of generations secured in a given interval of time. In fact, it has been demonstrated that roses can be hybridized in September, the immature embryos excised and cultured in December, and the resulting plant brought to flower by April—all within a 7-month period.

There are as yet many unexplored possibilities for application of the embryo culture technique, and many challenging questions are raised. For example, what is the status of a plant which has heretofore been considered sterile in nature and which by culture of its non-viable embryos produces viable seed?

And finally, many interesting relationships are found between the development of plant embryos and animal embryos. Because of the nature of the material, the incubation of immature plant embryos offers opportunity to observe embryos in large numbers at various ages and stages of development. Studies of the growth patterns produced and of the nutrients and cultural conditions required promise to throw light on animal embryology.

H. B. Tukey

SOME RECENT TRENDS IN GEOLOGY

GEOLOGY is one of the youngest sciences, having acquired the status of a science about 1800 by the publication of Playfair's interpretation of Hutton's classic and fundamental observations in England. It became firmly established in the family of natural sciences by William Smith's engineering work that led to stratigraphic studies and geologic mapping, and even more by Lyell's brilliant textbooks and articles in the 1830's and later years. About the same time, geologic articles and textbooks were appearing in the United States and state geological surveys were being organized. But a revealing light upon the infant science is cast by Merrill's observation that "at this date [1800 ca.] . . . none of the sciences were taught in the colleges and other institutions of learning in America or England. Indeed, the general trend of public opinion was decidedly against the study of geology. . . ." Landmarks of progress were established by the appointment, in 1802, of Benjamin Silliman at Yale and the founding, in 1818, of the American Journal of Science. Slightly more than a century thus measures the time of geology as a research science.

The youthful and virile science of geology made rapid progress during that century in interpreting man's environment and in discovering and utilizing geologic resources for the material welfare of society. It has developed into a mature science, the principles of which are of daily, widespread application in times of peace and of war in this age of the "Use of mineral resources." Geologic thought on fundamental principles has had various trends during this century of growth. A few of the 20th century trends are herewith interpreted.

The science of geology, like other sciences, has become more specialized during recent decades. Instead of geologic facts and principles being closely knit in a comprehensive unit, which any well-versed geologist could readily apprehend, field and laboratory research has resulted in the development of numerous branches as primary offshoots of the main trunk. Other sciences, particularly chemistry and physics, have nurtured some of the offspring until certain interrelations have become fixed. Some of the relatively new branches have grown into mature units; for example, the Geological Society of America at its 50th anniversary in 1938 recognized eight well-established major divisions of geology, which are subdivisible into twenty-five sections. In harmony with this decided trend toward specialization, the Geological Society and the American Association for the Advancement of Science have assisted the founding of several specialistic professional societies in the realm of the parent science of geology.

Pure research in geology and its economic applications have become more closely related during the 20th century. This trend no doubt will be accelerated by the urgent wartime need of the services of geologists and mining engineers to discover and develop adequate supplies of strategic minerals to win the war and mature the peace. Field work on all the continents and intensive research in industrial and university laboratories will support this trend. Pure research in most fields of geology may have slight opportunity to be cloistered in the post-war epoch of international industrial development.

A significant trend in economic geology has been the increased emphasis placed upon the diversity of local geologic environments in which recoverable quantities of petroleum may have accumulated. The need of extensive and intensive field exploration and laboratory research has been sharply accentuated by the depletion of our known petroleum reserves by the insatiable demands of this war. Full-scale post-war industrial activity and transportation will also require very large amounts of petroleum. Many types of "pure" research have in the last quarter century been skillfully applied to the solution of the general problem of increasing production from known fields and of discovering new fields.

Geophysics, the application of physics to the solution of geologic problems, has had a large part in some of the field programs since the first world war. The fundamental principles of sedimentation, once largely of academic interest only, have been more rigorously and widely applied. The study of

micro-faunas, also formerly of interest chiefly to paleontologists and biologists, has become an indispensable handmaiden of the geologist exploring for petroleum. More attention has recently been given to all the factors in the regional geologic history of a prospective petroleum district rather than to one or a few factors.

The sudden demands of the rapidly expanding armed forces and huge industrial plants throughout the nation for large quantities of ground water have focussed attention upon the fact that this indispensable, familiar geologic resource is locally limited in distribution and amount and that in many areas geologic principles and techniques must be applied in order to obtain adequate supplies. In consequence of such recent developments, ground water is becoming more and more recognized as being in the realm of economic geology. In passing, it appears strange that it has taken such a long time to classify ground water with other fluids in the rocks, to the acquisition of which geologic principles and techniques have been applied almost from the first industrial production.

Geologic field investigations and laboratory studies, made during the 20th century, of the fundamental constitution of coal have paved the way for a forthcoming technologic development of great industrial importance and individual interest; namely, the production of petroleum derivatives by the hydrogenation of coal. Synthetic gasoline is destined sometime, possibly within this generation, to take a strategic part in our national economy. Geologic and other scientific studies of vast deposits of "oil shale" also will have an important part in that forthcoming industrial drama.

Clay, long considered chiefly as the product of certain geologic processes and as an essential raw material in the ceramic industries, has become in the last decade or two the object of more critical geologic analysis. Not only are the results of industrial value, but the precise, quantitative studies have contributed to the solution of purely scientific problems in the realm of geology. The value of these studies in the solution of the manifold problems involved in a thorough study of our most basic geologic resource—the soil—has only recently become widely recognized. The new science of soil geology is developing in our midst.

Other mineral resources are being given precise study as never before. Limestone, for example, is no longer just a common rock. The chemical composition and physical constitution of many common earth materials and their relations to geologic environments are being determined on a quantitative rather than a qualitative basis. Exactitude in geologic research is supplanting, so far as possible, reconnaissance generalization.

Alongside the specialization of geology in recent decades and the development of more exact methods of field and laboratory research, another significant trend has been developing. In the early days of geology, the educated public had little difficulty in keeping informed about the significant discoveries and even of the development of some of the principal arguments. With the increasing specialization of the science, the public has wholly lost touch with many of its significant and socially important aspects. It may be more accurate to say that geologists have lost touch with the public. A significant sign of the times is that numerous geologists have become aware of the widespread lack of knowledge by the educated public as to what geology is and what it is good for. Thus have developed more and more attempts to interpret the findings of geologic research in terms that the educated public can understand.

ARTHUR BEVAN

BOOK REVIEWS

MATERNAL OVERPROTECTION*

THE twenty case studies in maternal overprotection presented in this book comprise the residual distillate of 2000 case records or 200,000 hours of case contacts accomplished at the former Institute for Child Guidance, New York City. Maternal overprotection is tentatively defined as ". . . a type of neurosis, in which especially processes of guilt result in exaggerated maternal care." The criterion of "pure" overprotection which determined selection of these cases is defined as ". . . exaggerated maternal love . . . overprotection which is not determined primarily by neurosis." This criterion was satisfied when the following characteristic relationships between mother and child prevailed: excessive contact; infantilization; prevention of independent behavior; and lack or excess of maternal control. These mothers, according to the findings of psychiatrists and social workers who participated in the study, manifested a strong "maternal drive." They were "naturally maternal" women whose maternal behavior had been intensified by psychic and cultural factors.

The life histories of the mothers revealed a deeply frustrated craving for love in childhood, anxieties during the period of anticipation, including in many cases a prolonged fear of sterility, and extra hazards concerning the child's health in infancy. Sexual incompatibility predominated in these marriages.

Direct psychotherapy with overprotected children in this study failed completely. As the author points out, "To expect a boy to overcome his mother's overprotection and modify behavior highly satisfying to him was certainly expecting too much." This observation should prove useful to many clinicians and social workers who adhere to the grim do-or-die philosophy in their contacts, especially in view of the unavoidable ego involvement which relationship therapy entails. This simple statement cuts many a Gordian knot of therapeutic failure in the clinic.

* *Maternal Overprotection.* David M. Levy. 417 pp. Sept., 1943. $4.50. Columbia University Press.

The book fairly bristles with exceedingly valuable clinical insights into the dynamics of overprotection and its treatment. For example, it was found that the attitudes of the mothers underwent little change despite the evidence of partially modified overt behavior. These fundamentally aggressive women really wanted help in re-establishing the mother-infant relationship and resented the clinic's attempt to lead the child into maturity.

The most successful techniques consisted of direct environmental change (camps) and specific advice combined with actual demonstration in the home. A follow-up survey of cases one or two years subsequent to therapy revealed that more than half of the children were partially or successfully adjusted. A later follow-up of nineteen cases into late adolescence or adult life indicated that more than sixty percent of this group were "partially adjusted." Whether the term "adjustment" is applicable in these cases is a debatable point. These follow-up studies highlight the perseverating effects of the silver-cord relationship.

Dr. Levy has made an important contribution by so lucidly delineating the dimensions of maternal overprotection and offering an operational blueprint of its ramified structure. The pitfalls and shortcomings of psychiatric treatment are candidly portrayed and should be of great value to young psychiatrists and psychiatric social workers who deal with this difficult problem. The multiplicity of etiological factors revealed in these studies should prove invaluable in orientating the accumulation of case history material in situations of this type. Research workers will find many challenges throughout the book.

The emphasis upon psychoanalytic rubrics might be deplored somewhat, as for example, such a statement as ". . . atonement in the form of good scholarship for the guilt of incestuous attachment." One wishes that other findings on overprotected boys, such as interest patterns, personality schedule, and Rorschach results, and other psychological and psychometric data could have been in-

cluded. The reader will also note considerable repetition of the case history material. Regardless of these faults, if faults they be, this book may be regarded as definitive in its field.

FRED BROWN

LIBERAL EDUCATION RE-EXAMINED*

BECAUSE the American Council of Learned Societies "has become increasingly aware of various forces in American culture, and trends in American education, which threaten the very basis of all scholarship," a committee was appointed to prepare this volume. Previous to the appointment of the committee in 1940, a symposium was held in 1938 in which there were participants from such important organizations as the Modern Language Association of America, The National Federation of Modern Foreign Language Teachers, The Classical Association of the Middle West and South, and the American Philological Association. That symposium produced the plan for a "thoroughgoing study of the place of the humanities in education," a plan which became the starting point for the committee's work.

The committee was instructed that its duties did not include a "defense of the humanities," but to "develop the full values of the contribution that the humanities must make to education and to life." And the committee in commenting (Preface) on its finished work said that its task had not been "to be primarily fact finding or statistical," but "to formulate basic cultural ideals and educational objectives, . . . to define a common cultural and educational goal, not to specify in detail the means whereby this goal may gradually be approached." Instead of outlining subjects, types of procedures, or integrated relations with other divisions of human records and achievements, by means of which the humanities may produce the desired results, the committee asks that "educational institutions throughout the country will attempt, on their own initiative and responsibility, to actualize the ideals here envisaged."

* *Liberal Education Re-Examined.* T. H. Greene, Fries, Wriston, and Dighton. xiv + 134 pp. 1943. $1.50. Harper & Bros.

Thus it might appear that the committee almost absolves itself from specifics, and uses an argumentative procedure which for more than fifty years has been a common method of dealing with the whole difficult problem. The fact that all the members of the committee and all the sponsoring organizations are directly concerned with the humanities might produce an expectancy that a reader of the book would meet abundant arguments for a very large place for humanities in general education. Such abundant arguments do appear; but concerning the large claims to which most humanists agree, it is stated that the members of the committee are not in full agreement; and of the American Council of Learned Societies, it is stated that "the scholars constituting this body were themselves in sharp disagreement on many crucial issues." Thus on an argumentative basis it seems that those who have spoken are not in full harmony. Possibly a fact finding basis might have produced a better foundation for unification in conclusions. The difficulty would have been in disclosing, analyzing, and synthesizing abundant facts to support what may have been predetermined contentions. By saying this, the reviewer does not mean to say that the argumentative conclusions are wrong. They are not proved by evidences of the objective sort which would be expected by other competent students of the same questions. Therefore, the conclusions are still within the domain of opinion, even though eminent and often convincing opinion.

A valuable point is made when referring to the cumulative nature of thinking about education. It is a mistake to assume that such thinking must be characterized either by the "horse and buggy" period or by the period of the stratosphere airplane. Rather it must be recognized that much thinking preceded "horse and buggy days" and there will be much to follow "stratosphere days." Even more significant is it that all along between such periods constructive consideration of education proceeded. The "fear that present trends have threatened the foundations of a humane as against a purely scientific education" is a fear that has grown steadily for many decades. Entrenched linguistics and other humanities felt the

growing impact of fact-finding sciences. The human betterments produced through science and the opportunities for vocational, as well as scholastic careers in science, shifted emphasis upon educational values. Undoubtedly, human desire for a livelihood as well as a life (the unctuous term "the good life" is frequently used), helped to shift educational emphasis from the humanities toward the sciences.

It is sometimes incorrectly implied by the writers that most of science deals with practicalities. It would be difficult, however, to arouse much public interest in adverse criticism of science because of its tremendous practical benefits. The book fails to note that point. Furthermore, it is idle talk to claim that persons educated through scientific pursuits are really less educated than are those who devote their abilities to the humanities. The sciences are not necessarily inhumanistic or uncultural, nor are the classics, languages, and literatures necessarily humanistic and cultural. It depends upon how they are approached, studied, used, and incorporated into one's living. The statement is made that "only liberally minded teachers and students can achieve a liberal education; for such education depends essentially upon contact of mind with mind in dealing with significant ideas." Does that mean that one must be liberally minded before he may achieve liberal mindedness?

Then, it is urged that the very long period during which certain subjects "have been reviewed, criticized, sharpened, and made more appealing and effective, . . . gives to these studies, which are the substance of the liberal arts, a unique quality which other disciplines can acquire only after like periods of developing maturity. . . . The liberal quality of education was bound to suffer by having the darling of the new education dominate what was left of the old. Science was too triumphant to be denounced." The authors then cite and deprecate the efforts of liberal arts subjects to become "scientific" by application of so-called scientific methods within their own fields. It seems clear that such efforts have not proved satisfactory.

This reviewer has constantly watched throughout the book for clear statements of what liberal education is. Several part definitions are given. "Liberal education seeks to bring into life greater refinement and greater intensity—to make it more sensitive, to make it more alive. . . . It is 'preparation' for life only in the sense that its vital influence is continuous and leads ever on from one experience to others which are even richer." In the chapter dealing with "The Ideal Objectives of a Democracy," when discussing what is best for development of political responsibilities, it is stated that "the most effective type of preparation both for citizenship and for the good life is a liberal education. Such education is, as we shall see, essentially cultural in content and reflective in approach." It is further asserted that a liberal education is "informative," "disciplinary," "liberative," and "moral," and is "the only effective education for the good life of the individual." "Education for citizenship, accordingly, is identical with education for the good life. A liberal education is the only education for either objective. . . . It alone can give men the factual knowledge, the sense of basic values, the perspective and critical attitude, requisite to responsible citizenship." Many other such quotations might be made. All of them are similarly assertive or argumentative and unsupported by tested evidences.

More than one-fourth of the book is devoted to the chapter on "Content of a Liberal Education," of which a little more than two pages suffice for "The Natural Sciences." Even so, the following closing sentence of that section is highly significant: "Whoever believes that it is more honest to face facts than to ignore them, and to interpret facts in a rational manner rather than an irrational manner, will value particularly this general contribution of science to man's intellectual and spiritual integrity." As expected, the really essential liberal studies, the languages, ancient and modern, the arts, literature, history, and philosophy are given the "central role" in a liberal education. And the arguments, excellently stated, include those recorded for many decades plus some that are ingeniously new. We believe many of them. In fact, most people want the cultural heritage of the humanities,

though there seems to be no good reason as to why these cultural values may not be developed along with the values of other types of liberal education than those advocated in this book.

Under "Various Academic Levels" the authors discuss, severely criticize, and make recommendations dealing with teaching and what is taught in all levels of education. These discussions and recommendations, most of which are interesting and sound, are strikingly more definite concerning elementary and secondary education in which none of the authors is working, than are those concerning collegiate and graduate education with which the authors are professionally closely associated.

OTIS W. CALDWELL

MAN'S FOOD: IT'S RHYME OR REASON*

THE main (and new) character of this volume on food is given by the author in the first paragraph of his introduction: "This volume differs from other books on food in that it deals as much with man as it does with food. Its main concern is with man's attitude towards food throughout history, before and during the evolution of the science of nutrition." While the book is written primarily for the lay public, the story of man's aberrations in regard to many good and wholesome natural foods, such as eggs, fish, meat, and milk, constitutes *must reading* even for experts on human nutrition, as this story helps to explain some of the current dietary aberrations in our country today, and familiarity with this story will be helpful to us all, and especially to those fellow citizens entrusted with the important duty of aiding a starving world, when the current war violence has subsided.

We may assume that all wild animals (including very early man) were, at least from time to time, forced to eat every available edible article of plant and animal sources. And it is a fact that all forms of animal and plant life contain elements useful as human food, even such rarely used plant products as grasses, leaves, and the fresh bark of trees. Very few plant and animal tissues anywhere in the world contain poisonous elements when used as human food. This being the case, the various taboos (religious, social, and sexual) against good foods developed by so many peoples, are in reality not primitive. For we cannot assume that their primary origin was special food idiosyncrasies (food anaphylaxis); as this appears in individuals, not in the tribe or group as a whole. It is not surprising, therefore, that some of these food taboos are current, even among relatively educated people today, even though the very origin of the food taboos presupposes two conditions: (a) almost complete ignorance as to the nature and functions of foods, and (b) plenty of foods not under taboo. Workers in nutrition would have found the human aspect of this volume more valuable if the author had cited at least some of his authorities. There is no literature reference in any of the eighteen chapters.

Most of the specific food data and dietary recommendations in the several chapters are not only factual but clearly and interestingly presented for the lay reader. Wholly erroneous assertions, like the following, are exceptional: "The value of fruits and vegetables lies wholly in their possession of small quantities of vitamin C" (p. 37). But readers might ask the author for the evidence for the claim (p. 201) "deficiency in vitamins is one of the causes for high infant mortality" (in U. S. A., presumably).

There are chapters on "Table Manners," "Food and Morale," and a "Postscript on Freedom from Want of Food." Considering the times and the author's connections, the reader should not be surprised to encounter some rather wishful thinking, if not *lapsus menti,* in some of these chapters. Thus the author says (p. 58) that our current flour and bread enrichment practices "have solved the entire problem (of denaturing our food grains) pleasantly and effectively." The solution may be pleasant to some, but is it effective for all, and for all times? Is it as effective as whole wheat, taboos or no taboos? On page 29 we read: "The percentage of malnutrition (in U. S. A.) is much smaller than the mythical, and by now classical, third." This does not seem to square with

* *Man's Food: Its Rhyme or Reason.* Mark Graubard. x + 213 pp. Nov., 1943. $2.50 ($2.00 to members of the American Association for the Advancement of Science, if ordered through this Association). Macmillan.

his statement on page 201: "surveys show that the majority of our (U. S. A.) population is malnourished." Do we have to be convinced and convicted of total depravity before we accept salvation?

A. J. Carlson

FOOD IN WAR AND PEACE

When a subject becomes so popular as to figure almost daily on the front and editorial pages of newspapers, over the radio, in magazines, and in the newsreels—then that subject stands a pretty good chance of being confounded and misunderstood. When, in addition, the subject happens to be food which is linked to science, nutrition education as well as war and peace, then the misconceptions, false warnings, fears, and useless oratory bubbling around it may well reach extraordinary proportions. It is for these reasons that the American people are fortunate in having had a 1943 Christmas gift in the form of *Food "Crisis"*[1] by Roy F. Hendrickson and *Food Enough*[2] by John D. Black.

Mr. Hendrickson's book is a model of clear exposition and complete coverage. It is intended for the layman and its style, its contents, and organization are so expertly directed toward that objective that the result is a most lucid account of the food situation in the United States and its effect upon the rest of the world. It reads like a novel and is written in a concise but mellow style without embellishment but with an inherent ease of flow which carries the reader along thoroughly interested, thoroughly pleased because he is really learning point by point the elements of a complicated but fascinatingly elucidated problem.

What is most gratifying is that the subject is handled with reserve, dignity, and unique impartiality, which are particularly striking in view of Mr. Hendrickson's responsibility as director of the Food Distribution Administration. There is no condescension in tone often displayed by so many who write for the laymen, and there is no trace of seeking to defend policies simply because the author happened to be involved in their adoption. The book is a classic achievement in adult education which analyzes the food problem and its numerous aspects frankly and honestly with authoritative knowledge and impelling logic.

After presenting a survey of the present food situation under the heading, "America Wakes Up—To Face a Food Problem," the author considers the war tasks at home in the matter of adequate food for the civilian population, the needs of the military and the Allies, the problems of Lend-Lease and of feeding occupied lands. He next considers the questions of rationing, prices, subsidies, and the problems confronting the farmer on the production front. Especially informative are the chapters dealing with the way Britain is solving her food problem and how her methods compare with our own. The reader is also offered a thorough picture of the role of food in World War I and the present food situation in Germany. The concluding chapters deal with tasks still requiring careful thought regarding post-war possibilities on the food front. One almost feels confident that if the professional Cassandras and other vociferous critics could only take time off to read this volume our road to victory would be far smoother than it is with their present clamor. The average citizen stands to learn much from reading this book. He will learn how difficult the problem has been, how much there was to do, how it is being handled now and how easy it is to be an arm-chair food philosopher offering glib solutions for all domestic and foreign difficulties. But the problems of feeding our population, our armed forces, and aiding our allies are in reality quite tough. Yet these jobs have been done fairly well.

Professor Black's book runs much along the same lines as Mr. Hendrickson's. It is briefer and amply furnished with charts and tables. It too is an excellent account of the food situation and the charts and tables it offers are so clear that their aid in summarizing complex data is apparent to anyone. Professor Black's outline follows more or less the same sequence as Mr. Hendrickson's since both are motivated by the logic of the story they have to tell. The approaches taken by each are sufficiently different to

[1] *Food "Crisis."* Roy F. Hendrickson. xii + 274 pp. 1943. $2.50. Doubleday, Doran.

[2] *Food Enough.* John D. Black. 269 pp. 1943. $2.50. The Jaques Cattell Press.

make both books prescribed reading for anyone concerned in any way with food, its production, distribution, or use.

Besides its wealth of information, clarity of style, and plethora of data, Professor Black's book is of special interest in that it comes from the pen of one of the ablest students of food economics not in the employment of the government. His judgment is consistently fair and his points of criticism are certainly to be taken seriously. His general conclusions that the food situation has been handled with competence and as well as could be expected under the circumstances, should be encouraging to the public. His critical comments should be found stimulating especially by those who are responsible for national strategy on the food front.

One positive point may be made after reading these two enjoyable and instructive volumes. There can no longer be any good excuse for nonsense on the subject of food sown broadcast or otherwise dispensed by common people, their representatives, professional authors, radio commentators, or editorial writers. The facts are available and just as the public reads war books it should read these two works which deal with the basic war problem of food. Moreover, while intimate knowledge of the fighting in Italy or the Solomons does not in all likelihood make a better citizen or a more valuable armchair strategist, knowledge of what is involved in solving our food problems is a contribution to good citizenship. Victory on the food front can be achieved only by the wholehearted cooperation of farmer, manufacturer, and consumer. It is the duty of each citizen to know what is involved in solving the various aspects of the food problem. After reading these books, the average citizen is really put in the position of an intelligent democratic participant on the home front.

MARK GRAUBARD

SHRUBS OF MICHIGAN*

THE Cranbrook Institute of Science and Mr. Billington should be commended for this excellent book presenting in such precise and readable form the shrubs of Michigan. In this work 161 species of shrubs, all that are known to occur in Michigan, are included, each represented by drawings of fruit, leaves, flowers, and inflorescence, and accompanied by a small map of Michigan outlining the counties and indicating actual records.

The drawings have been very simply, neatly, and accurately executed, and are indispensable in a work of this kind designed especially for the nature lover and those who cannot be professional botanists. A color frontispiece, depicting autumnal coloration transforming a zone of shrubs to crimson against a background of dark green coniferous trees, adds an attractive artistic feature.

The keys to the genera and those to the species in the text are clear and workable, more especially because eighty-eight line drawings in a pictorial glossary illustrate many of the descriptive botanical terms with which the amateur might not be familiar.

The reviewer feels that this book will be of great value to all nature lovers and amateur botanists who wish to familiarize themselves with the native shrubs of their state. There is a need for more books of this sort, for they have great educational value for thousands of persons who have not had the training nor the inclination to become professional botanists or taxonomists. Such books, with the subject matter presented attractively, clearly, and accurately, are of far greater usefulness to the average person than technical monographs or manuals covering large areas of the country. *Shrubs of Michigan* by Mr. Billington is in this class.

H. A. ALLARD

* *Shrubs of Michigan.* Cecil Billington. Bulletin No. 20. Illustrated. 249 pp. Dec., 1943. $2.50. Cranbrook Institute of Science.

COMMENTS AND CRITICISMS

Apology

We shall not wait for a reader to ask us who wrote the article on the work of Dr. Frank Schlesinger, which was published under the title, "Explorer of Celestial Spaces" in the March issue of *The Scientific Monthly,* pp. 240–242. This article was an abridged version of an address by Dr. Henry Norris Russell, which he delivered at the exercises in memory of Dr. Schlesinger in Strathcona Hall, Yale University, November 19, 1943. We regret the inadvertent omission of Dr. Russell's name at the end of his article and offer our apologies to him and to our readers.—Eds.

War Effort

I have unfortunately misplaced the letter you sent me and, by golly, I can't remember your name. I think it is Carpenter, but I am not sure. At all events, the reproof in your letter was merited in part. I haven't been asleep at the switch, but I found that I wasn't as good a listening post as I thought. In addition to this, much of the work being done by anthropologists today is in connection with the war effort and there is a certain amount of hush-hush about it. At all events I have written an item for "Science on the March" which now has to go through the red tape of army clearance. If you will sit tight for all of this rigamarole, you should have something from me one of these days. I saw Dr. Moulton last Sunday and explained to him that I have darn near bitten off more than I can chew. However, I will keep plugging and will do my best.—Wilton M. Krogman.

Our contributing editors *are* doing their best to supply timely and illuminating articles for "Science on the March." While their articles are germinating or being cleared, "Carpenter" has been sawing wood to fill space. He regrets the necessity of giving our readers an overdose of insecticides and hopes that his specialty will not obtrude again. This note is written to invite contributions for "Science on the March" from our readers.—Eds.

Diethylstilbestrol

The objective of your new section "Science on the March" is very much worthwhile. Scientific progress is rapid on so many fronts that it is extremely difficult for one to keep his head above water even in his special field.

However, such a section, to achieve its purpose, must be edited with extreme care. In the January issue under the heading "synthetic sex hormones" I find a confusion between "stilbestrol" and diethylstilbestrol (to use the American spelling). This confusion is probably a reflection of the fact that in the U.S.A. "stilbestrol" has often been used where "diethylstilbestrol" was meant. The Council on Pharmacy and Chemistry of the American Medical Association has not always agreed with the Food and Drug Administration in this regard.

In his original publication, Dodds reported the preparation and testing of several derivatives of stilbene (diphenylethylene). Among these were 4,4′-stilbenediol and α,β-diethyl-4,4′-stilbenediol. The latter compound has achieved considerable clinical use both under the name "diethylstilbestrol" and "stilbestrol." The former name was first assigned as the "common name" by the Food and Drug Administration. The Council sanctioned the latter.—E. Leon Foreman.

At the bottom of the first column on page 80 of the January, 1944, issue of *The Scientific Monthly* the editor innocently published: "A derivative of stilboestrol, known as diethylstilboestrol. . . ." Dr. Foreman points out above that these two common names are synonymous, both referring to the chemical compound α, β-diethyl-4,4′-stilbenediol. The Food and Drug Administration now requires the commercial product to be labeled under the name diethylstilbestrol, which may be regarded as the name generally accepted in the United States for this synthetic sex hormone. —Eds.

Interpretation

I am wondering whether the exclamation "oh" on page 164 of the February issue of *The Scientific Monthly* was occasioned by the second sentence of the item which contains two well-defined grammatical errors.—Curvin H. Gingrich.

An Astronomer's View

Dr. G. A. Lundberg's statement concerning postwar efforts ("Scientists in War Time," *The Scientific Monthly,* February 1944, p. 89) that, "No matter who wins, appeasement and compromise will occur because there is, practically speaking, no alternative," is surprising. If he means that in connection with the peace settlement, appeasement and compromise will not be wholly absent, few will disagree. But apparently he thinks that the peace terms must consist wholly or essentially of appeasement and compromise, for the next sentence reads, "The only subjects for profitable discussion are the details of the appeasement and compromise."

The context supplies one or two arguments for this disheartening conclusion. One is that after

World War I "the machinery of appeasement and compromise was set in motion." But does this fact prove that after World War II no other machinery can possibly be used? Dr. Lundberg's argument is marred by a misstatement. "No one could have desired a more complete military victory than that achieved by the Allies in the first World War." It is reported that General Pershing desired a more complete victory.

Dr. Lundberg indicates that annihilation of the defeated nations would be an oversimplified and unavailable solution. His failure to discuss a third possibility, namely, that after victory the Allied Nations might force Germany and Japan to follow a prescribed course is puzzling; it seems to me to leave his treatment narrow and unsatisfactory.

In the absence of an impartial judge, does any moral principle of symmetry require that after the war we refrain from enforcing our ideas just because we think we would dislike what Germany would do to us had she been the victor? The vigilante type of justice may not be ideal but it is probably better than none at all. The Golden Rule is not available for the protection of a nation that violates it.—Paul W. Merrill.

From an Editor

Since you kindly invited my comments on the January issue I should like to make a few remarks. The choice of original articles seems to me almost perfect; all of them are on timely and interesting subjects. I think, too, that the section on "Meet the Authors" is a great addition. It seems, however, that comparatively few qualified workers in science possess much ability to write clearly for the general public; the conclusion I think is that more work should be expended on editing papers of this kind than almost any other type of published material.

I think it might be advantageous to consider setting up a small department for publication of correspondence. It is my belief that when suitably controlled, correspondence can form an exceptionally interesting part of a magazine or newspaper. The section on Science on the March is excellent and might I think be expanded to include items of spot news in science and, perhaps, even some personal news.—Edwin P. Jordan.

To J. O. Perrine

I cannot refrain from sending you my thanks for the most elucidating exposition of electromagnetic waves I have yet seen, and which I have just finished reading the second time.

I have long had a hobby in physics and enjoy the study greatly when as in your case the subjects are presented from "the bottom up" instead of from "the top down." I have been reading *The Scientific Monthly* for years and shall always preserve the January, 1944, issue.—David J. Lewis.

To the New Editor

Methinks I see Frank in his new office chair,
A-wrinkling his eyebrows and pulling his hair,
Redacting like mad on some horrible script
And thinking how much of it ought to be skipped.

Correcting, amending, adjusting and then,
By aid of his much over-worked office pen,
Removing a colon, inserting a dash,
Re-writing a sentence that's too much like hash.

At home and in bed, when he's trying to sleep,
He'll have to count commas instead of the sheep.
At last when he's finally slumbering there,
The marks diacritic will get in his hair.

Inverted construction will give him a pain,
The wrong use of words will confuse his tired brain,
While nightmares composed of the bum paragraphs
Cavort on his tummy with devilish laughs.

There's no easy chair in the editor's suite
And you can demolish your pants in the seat
As fast as you could if you still were to be
Assigned to a "chair" in the old B. & Z.

—Raymond C. Osburn.